

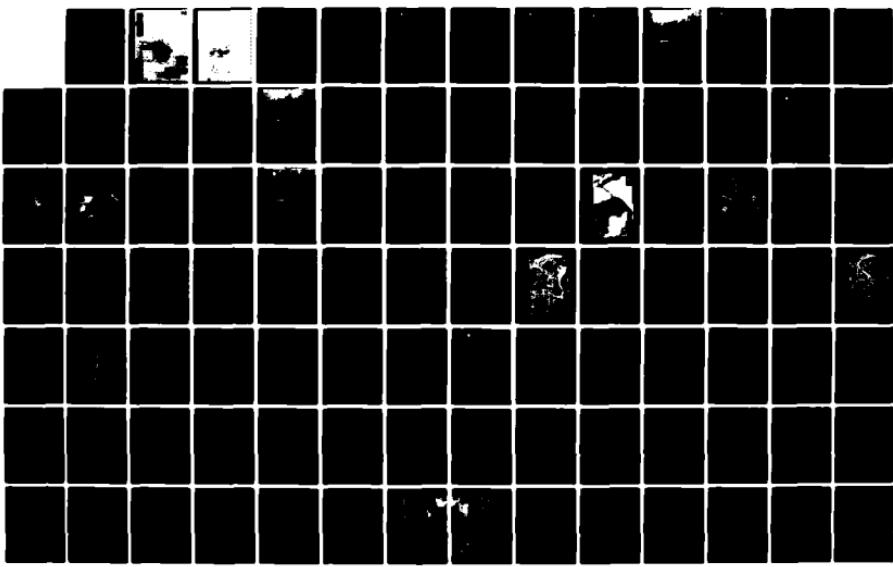
AD-A126 016 INSTALLATION RESTORATION PROGRAM RECORDS SEARCH FOR
TWIN CITIES AIR FORCE RESERVE BASE MINNESOTA(U) CH2M
HILL GAINESVILLE FL MAR 83 F08637-80-G-0010

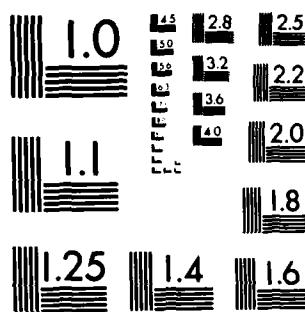
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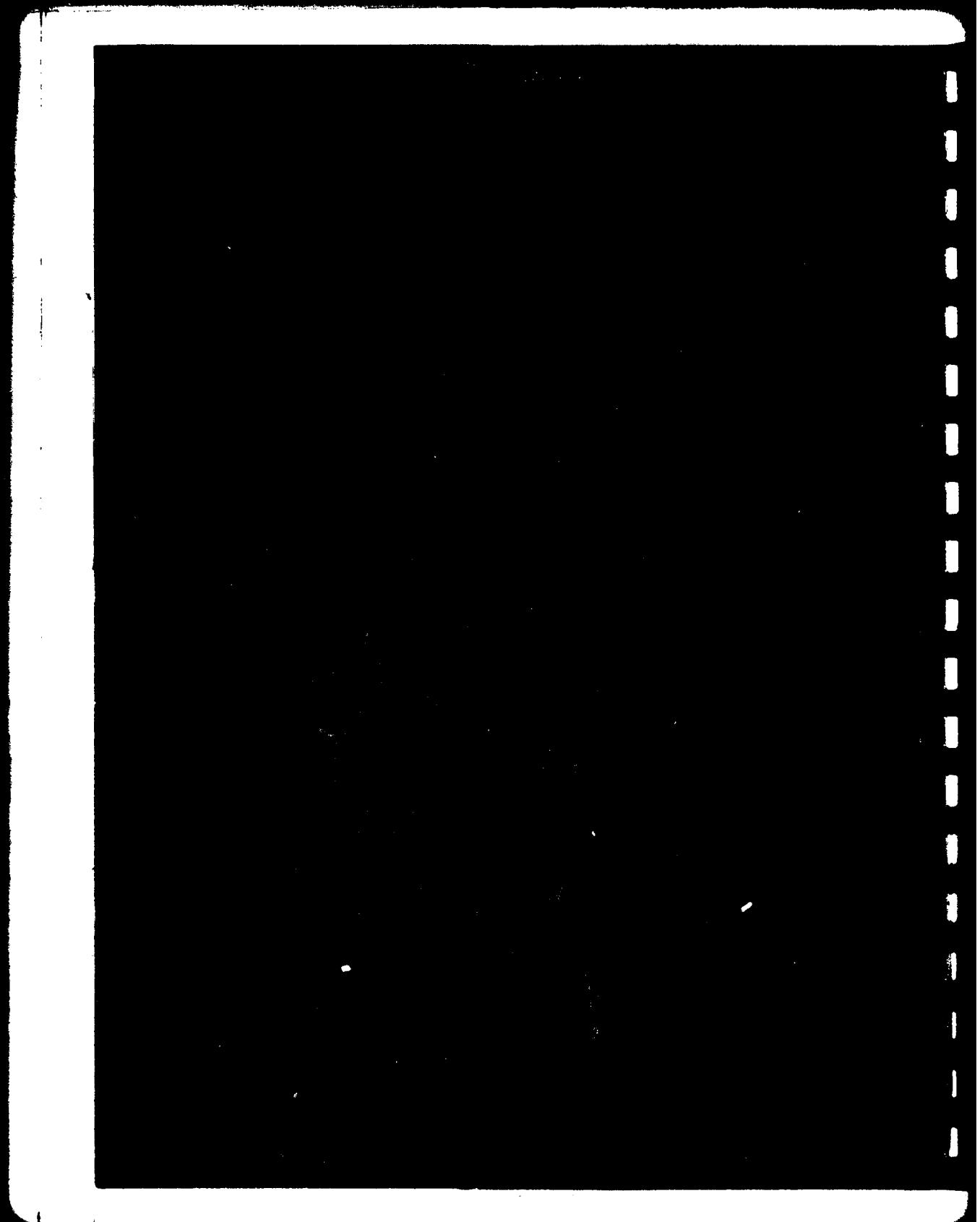




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INSTALLATION RESTORATION
PROGRAM RECORDS SEARCH

For

TWIN CITIES AIR FORCE RESERVE BASE, MINNESOTA

Prepared for

AIR FORCE ENGINEERING AND SERVICES CENTER
DIRECTORATE OF ENVIRONMENTAL PLANNING
TYNDALL AIR FORCE BASE, FLORIDA 32403

AND

AIR FORCE RESERVE
ROBINS AIR FORCE BASE, GEORGIA 31098

By

CH2M HILL
Gainesville, Florida



March 1983

Contract No. F0863780 G0010 6N01

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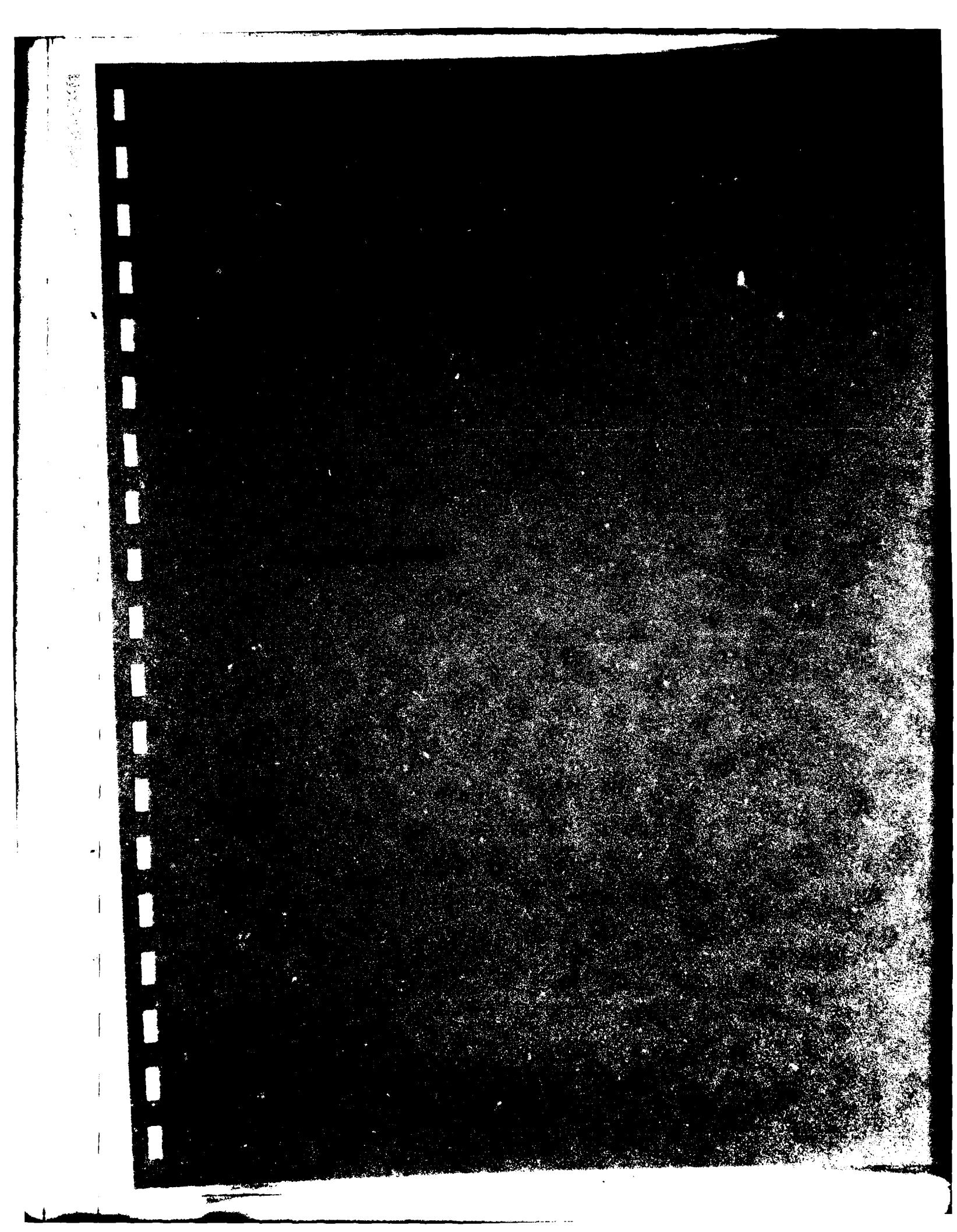
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EXECUTIVE SUMMARY

A. INTRODUCTION

1. CH2M HILL was retained on September 24, 1982, to conduct the Twin Cities Air Force Reserve Base (AFRB) records search under Contract No. F08637-80-G0010-6N01, with funds provided by the Air Force Reserve (AFRES).
2. Department of Defense (DoD) policy, directed by Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, is to identify and fully evaluate suspected problems associated with past hazardous material disposal sites on DoD facilities, control the migration of hazardous contamination from such facilities, and control hazards to health and welfare that may have resulted from these past operations.
3. To implement the DoD policy, a four-phase Installation Restoration Program has been directed. Phase I, the records search, is the identification of potential problems. Phase II (not part of this contract) consists of follow-on field work as determined from Phase I. Phase II consists of a preliminary survey to confirm or rule out the presence and/or migration of contaminants and, if necessary, additional field work to determine the extent and magnitude of contaminant migration. Phase III (not part of this contract) consists of a technology base development study to support the development of project plans for controlling migration or restoring the installation. Phase IV

(not part of this contract) includes those efforts which are required to control identified hazardous conditions.

4. The Twin Cities AFRB records search included a detailed review of pertinent installation records, contacts with 17 government organizations for documents relevant to the records search effort, and an onsite base visit conducted by CH2M HILL during the week of November 15 through November 19, 1982. Activities conducted during onsite base visit included interviews with 40 past and present base employees, a ground tour of the installation, a detailed search of installation records, and a helicopter overflight to identify past disposal areas.

B. MAJOR FINDINGS

1. The major industrial operations at Twin Cities AFRB include corrosion control shops, flight line maintenance shops, inspection sections, propulsion shops, pneumdraulics shops, aerospace ground equipment maintenance shops, non-destructive inspection labs, and vehicle maintenance shops. These industrial operations generate varying quantities of waste oils, contaminated fuels, and spent solvents and cleaners.
2. The majority of the industrial activities are conducted by the 934th Tactical Airlift Group, AFRES (base host unit) and the Minnesota Air National Guard (tenant unit). The two units operate independently and each unit maintains eight C-130 aircraft.

3. Many of the industrial activities conducted by the Air Force have been in existence since the 1940s. The standard procedures for final disposition of waste oils have been (1) contractor removal (1943 to 1975); (2) contractor removal and salvage through the Defense Property Disposal Office (DPDO) (1975 to 1981); and (3) salvage through DPDO (1981 to present). The standard procedures for final disposition of spent solvents have been as follows: (1) commingle with waste oils and remove by a contractor (1943 to 1975); (2) contractor removal and salvage through DPDO (1975 to 1981); and (3) DPDO accepts accountability, but not physical custody, and issues a contract for removal (1981 to present). The standard procedure for final disposition of contaminated fuels has been fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area (1943 to present).
4. Many of the industrial activities conducted by the Minnesota Air National Guard have been in existence since the early 1950s. The standard procedures for final disposition of waste oils have been (1) contractor removal and road oiling at Camp Ripley (1951 to 1975); and (2) contractor removal (1975 to present). The standard procedures for final disposition of spent solvents have been (1) contractor removal and road oiling at Camp Ripley (1951 to 1975); and (2) salvage through DPDO (1975 to present). The standard procedure for final disposition of contaminated fuels has been fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area (1951 to present).

5. Many of the industrial activities conducted by the Navy have been in existence since the early 1930s. The standard procedures for final disposition of waste oils and spent solvents have been (1) commingle and remove by a contractor (prior to 1970); and (2) segregate and remove by a contractor (1970 to present). The standard procedure for final deposition of contaminated fuels has been fire department training exercises at the Metropolitan Airports Commission Fire Department Training area (1940s to present).
6. Interviews with past and present base employees resulted in the identification of nine past disposal or spill sites at Twin Cities AFRB and the approximate dates that these sites were used.

C. CONCLUSIONS

1. Information obtained through interviews with 40 past and present base personnel, base records, shop folders, and field observations indicate that small quantities of hazardous wastes have been disposed of on Twin Cities AFRB property in the past.
2. No evidence of environmental stress resulting from past disposal of hazardous wastes was observed at Twin Cities AFRB.
3. The potential for migration of hazardous contaminants in Areas A, C, D, and N is low because of (1) low ground-water table, and (2) the presence of low-permeability confining strata in the unsaturated zone above the uppermost aquifer.

Although low, the potential for contaminant migration exists because of the moderate permeability of the soil beneath the low-permeability confining strata.

4. The potential for migration of hazardous contaminants in Area B (Small Arms Range) is high because of (1) high ground-water table, (2) moderate soil permeability, (3) proximity to the Minnesota River and location within the 100-year flood plain, and (4) absence of the low-permeability confining strata (Platteville Limestone and Glenwood Shale) in the unsaturated zone above the water table.
5. Table 1 presents a priority listing of the rated sites and their overall scores. The Small Arms Range Landfill (Site No. 1) was designated as the area showing the most significant potential (relative to other Twin Cities AFRB sites) for environmental impact.
6. The remaining sites (Sites No. 4, 5, 6, 7, and 8) are not considered to present significant environmental concerns. Therefore, no Phase II work is recommended.

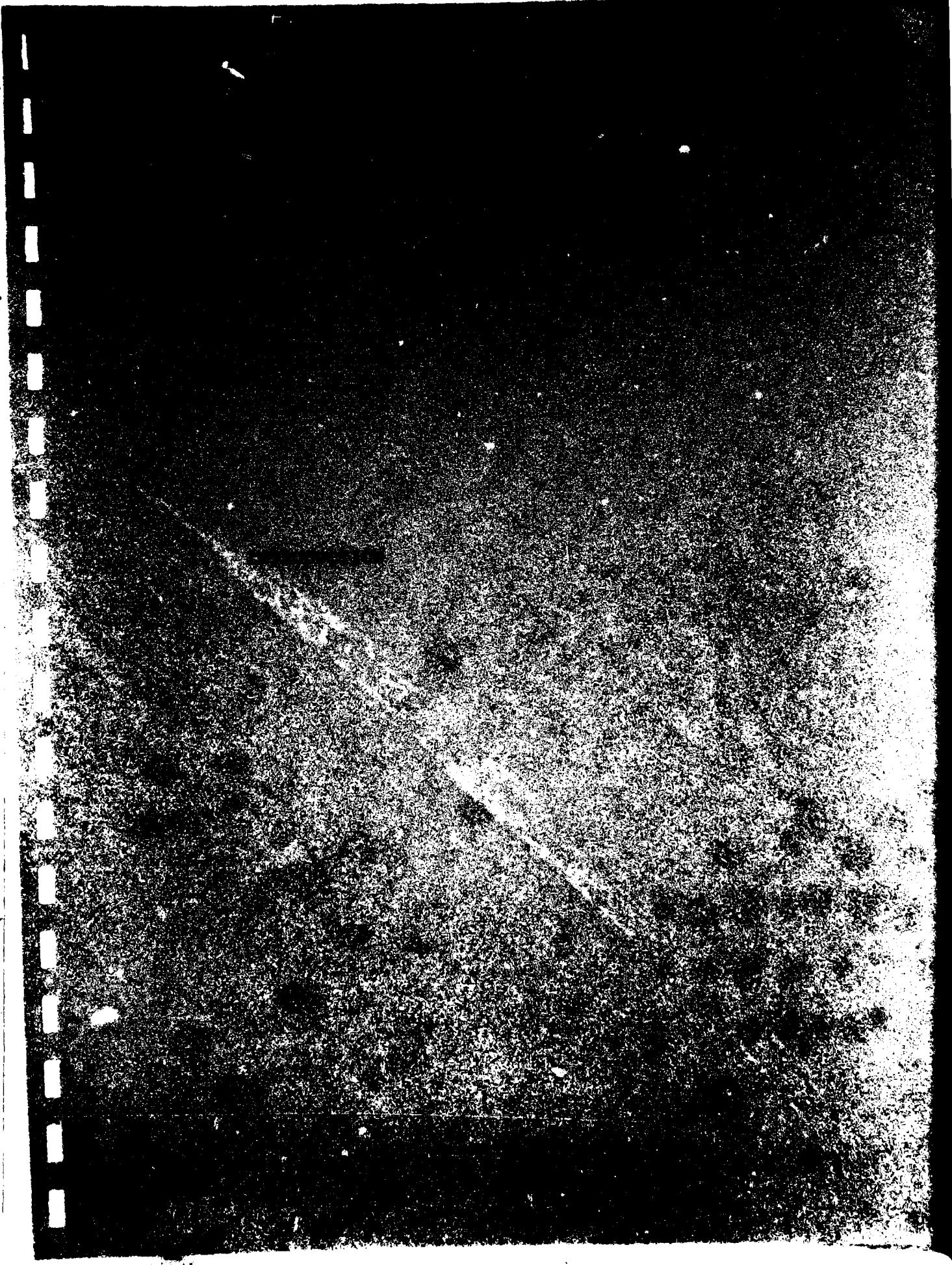
D. RECOMMENDATIONS

1. A limited Phase II monitoring program is recommended to confirm or rule out the presence and/or migration of hazardous contaminants. The details of the Phase II monitoring program are provided in Section VI, "Recommendations." The priority for monitoring at Twin Cities AFRB is considered low to moderate, since no imminent hazard has been determined.

Table 1
PRIORITY LISTING OF DISPOSAL SITES

<u>Site No.</u>	<u>Site Description</u>	<u>Overall Score</u>
1	Small Arms Range Landfill	60
7	Past Fuel Spill Area	56
8	Hazardous Storage Area	56
5	Suspected POL Spill Area	55
6	Liquid Sludge Burial Pit	53
4	MOGAS Spill	52

2. Specifically, initial monitoring is recommended for the Small Arms Range Landfill located in Area B.
3. The final details of the monitoring program, including the exact locations of ground-water monitoring wells, will be finalized as part of the Phase II program.
4. In the event that contaminants are detected, a more extensive field survey program should be implemented to determine the extent of contaminant migration.



I. INTRODUCTION

A. BACKGROUND

The United States Air Force (USAF), due to its primary mission, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. Federal, state, and local governments have developed strict regulations to require that disposers identify the locations and contents of disposal sites and take action to eliminate hazards in an environmentally responsible manner. The primary Federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Sections 3012 and 6003 of the Act, Federal agencies are directed to assist the Environmental Protection Agency (EPA) and state agencies to inventory past disposal sites and make the information available to the requesting agencies. To assure compliance with these hazardous waste regulations, the Department of Defense (DoD) developed the Installation Restoration Program (IRP). The current DoD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 dated 11 December 1981 and implemented by Air Force message dated 21 January 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the Installation Restoration Program. DoD policy is to identify and fully evaluate suspected problems associated with past hazardous material disposal sites and spill sites on DoD facilities, and to control hazards to health and welfare that may have resulted from these past operations. The IRP will be a basis for remedial actions on Air Force installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, and clarified by Executive Order 12316.

To conduct the Installation Restoration Program Records Search for Twin Cities AFRB, CH2M HILL was retained on September 24, 1982, under Contract No. F0863780 G0010 6N01 with funding provided by the Air Force Reserve (AFRES).

The records search comprises Phase I of the DoD Installation Restoration Program and is intended to review installation records to identify possible hazardous waste-contaminated sites and to assess the potential for contaminant migration from the installation. Phase II (not part of this contract) consists of follow-on field work as determined from Phase I. Phase II consists of a preliminary survey to confirm or rule out the presence and/or migration of contaminants and, if necessary, additional field work to determine the extent and magnitude of the contaminant migration. Phase III (not part of this contract) consists of a technology base development study to support the development of project plans for controlling migration or restoring the installation. Phase IV (not part of this contract) includes those efforts which are required to control identified hazardous conditions.

B. AUTHORITY

The identification of hazardous material disposal sites at Air Force installations was directed by Defense Environmental Quality Program Policy Memorandum 81-5 (DEQPPM 81-5) dated 11 December 1981, and implemented by Air Force message dated 21 January 1982, as a positive action to ensure compliance of Air Force installations with existing environmental regulations.

C. PURPOSE OF THE RECORDS SEARCH

The purpose of the Phase I records search is to identify and evaluate suspected problems associated with past

hazardous material disposal sites and spill sites on DoD facilities. The existence and potential for migration of hazardous material contaminants was evaluated at Twin Cities AFRB by reviewing the existing information and conducting an analysis of installation records. Pertinent information includes the history of operations, the geological and hydrogeological conditions which may contribute to the migration of contaminants, and the ecological settings which indicate environmentally sensitive habitats or evidence of environmental stress.

D. SCOPE

The records search program included a pre-performance meeting, an onsite base visit, a review and analysis of the information obtained, and preparation of this report.

The pre-performance meeting was held at Twin Cities AFRB, Minneapolis, Minnesota, on September 28, 1982. Attendees at this meeting included representatives of the Air Force Engineering and Services Center (AFESC), AFRES, Twin Cities AFRB, and CH2M HILL. The purpose of the pre-performance meeting was to provide detailed project instructions, to provide clarification and technical guidance by AFESC, and to define the responsibilities of all parties participating in the Twin Cities AFRB records search.

The onsite base visit was conducted by CH2M HILL from November 15 through November 19, 1982. Activities performed during the onsite visit included a detailed search of installation records, a ground tour of the installation, a helicopter overflight, and interviews with 40 past and present base personnel. At the conclusion of the onsite base visit, an outbriefing was held to discuss the preliminary findings. The following individuals comprised the CH2M HILL records search team:

1. Mr. Greg McIntyre, Project Manager/Environmental Engineer (M.S. Environmental and Water Resources Engineering, 1981)
2. Mr. Gary Eichler, Hydrogeologist (M.S. Engineering Geology, 1974)
3. Mr. Brian Winchester, Ecologist (B.S. Wildlife Ecology, 1973)

Resumes of these team members are included in Appendix A. Government organizations were contacted for information and relevant documents. Appendix B lists the organizations contacted.

Individuals from the Air Force who assisted in the Twin Cities AFRB records search included the following:

1. Mr. Myron Anderson, AFESC, Program Manager, Phase I
2. Major Gary Fishburn, USAF OEHL, Program Manager, Phase II
3. Capt. Gail Graban, AFESC, Phase I Representative
4. Mr. Larry Garrett, AFRES, Command Representative
5. Major Kenneth Hundley, AFRES, Command Bioenvironmental Engineer
6. Mr. Joe Maccani, Twin Cities AFRB, Environmental Coordinator
7. Capt. William Anderl, Twin Cities AFRB, Bioenvironmental Engineer

8. Ms. Margaret Marx, Twin Cities AFRB, Environmental Health Nurse

9. Dr. Grady Maraman, AFRES, Command Environmental Coordinator

E. METHODOLOGY

The methodology utilized in the Twin Cities AFRB records search is shown graphically on Figure 1. First, a review of past and present industrial operations is conducted at the base. Information is obtained from available records such as shop files and real property files, as well as interviews with past and present base employees from the various operating areas of the base. The information obtained from interviewees on past activities is based on their best recollection. A list of 40 interviewees from Twin Cities AFRB, with areas of knowledge and years at the installation, is given in Appendix C.

The next step in the activity review process is to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from all the industrial operations on the base. Included in this part of the activity review is the identification of past landfill sites and burial sites, as well as other possible sources of contamination such as major PCB or solvent spills or fuel-saturated areas resulting from significant fuel spills or leaks.

An aerial overflight and a general ground tour of identified sites is then made by the records search team to gather site-specific information including evidence of environmental stress and the presence of nearby drainage ditches or surface-water bodies. These water bodies are

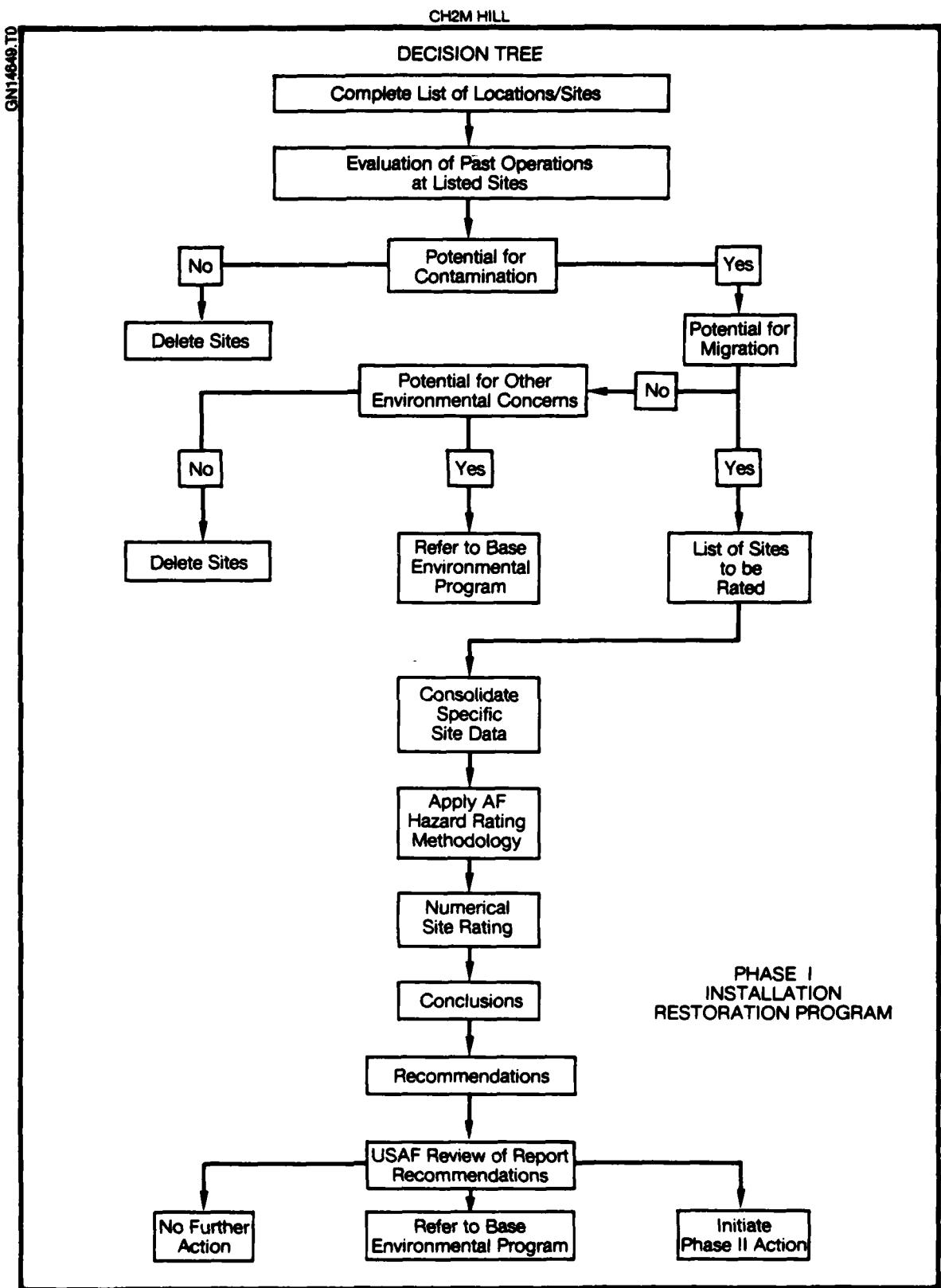


FIGURE 1. Records search methodology.

inspected for any evidence of contamination or leachate migration.

A decision is then made, based on all of the above information, as to whether a potential exists for hazardous material contamination from any of the identified sites. If not, the site is deleted from further consideration. If minor operations and maintenance deficiencies are noted during the investigations, the condition is reported to the Base Environmental Coordinator for further action.

For those sites at which a potential for contamination is identified, the potential for migration of this contamination is evaluated by considering site-specific soil and ground-water conditions. If there is no potential for contaminant migration, but other environmental concerns were identified, the site is referred to the base environmental monitoring program for further action. If no further environmental concerns are identified, the site is deleted from further consideration. If the potential for contaminant migration is identified, then the site is rated and prioritized using the site rating methodology described in Appendix G, "Hazard Assessment Rating Methodology."

The site rating indicates the relative potential for environmental impact at each site. For those sites showing a significant potential, recommendations are made to quantify the potential contaminant migration problem under Phase II of the Installation Restoration Program. For those sites showing a low potential, no Phase II work is recommended.

II. INSTALLATION DESCRIPTION

II. INSTALLATION DESCRIPTION

A. LOCATION

Twin Cities AFRB is located at the Minneapolis-St. Paul International Airport. The airport is located near the confluence of the Minnesota and Mississippi Rivers and lies just south of the Minneapolis city limits. The location map of Twin Cities AFRB and the Minneapolis-St. Paul International Airport is shown on Figure 2. The base is comprised of five separate areas on a total of approximately 284 acres. The site map of Twin Cities AFRB is shown on Figure 3. The five USAF-owned areas comprising the Twin Cities AFRB are shown on the figure and are described as follows:

Area A (5.64 Acres): Area A, the Officers Club Annex, is situated on a bluff overlooking the Minnesota River. The Officers Open Mess, the oldest building on-base, is located at this site. Area A was acquired by the USAF in 1955.

Area B (26.9 Acres): Area B, the Small Arms Range, is located adjacent to the Minnesota River. The outdoor Small Arms Range is used by more than 25 organizations throughout the year. Area B was acquired by the USAF in 1955.

Area C (19.4 Acres): Area C is primarily occupied by the Navy Air Reserves and Marine Reserves. Area C was previously occupied by the USAF from 1943 to 1971, at which time the AFRES relocated from Areas C and D to Area N. The Minnesota Air National Guard also occupied Area C during the period between 1951 and 1957.

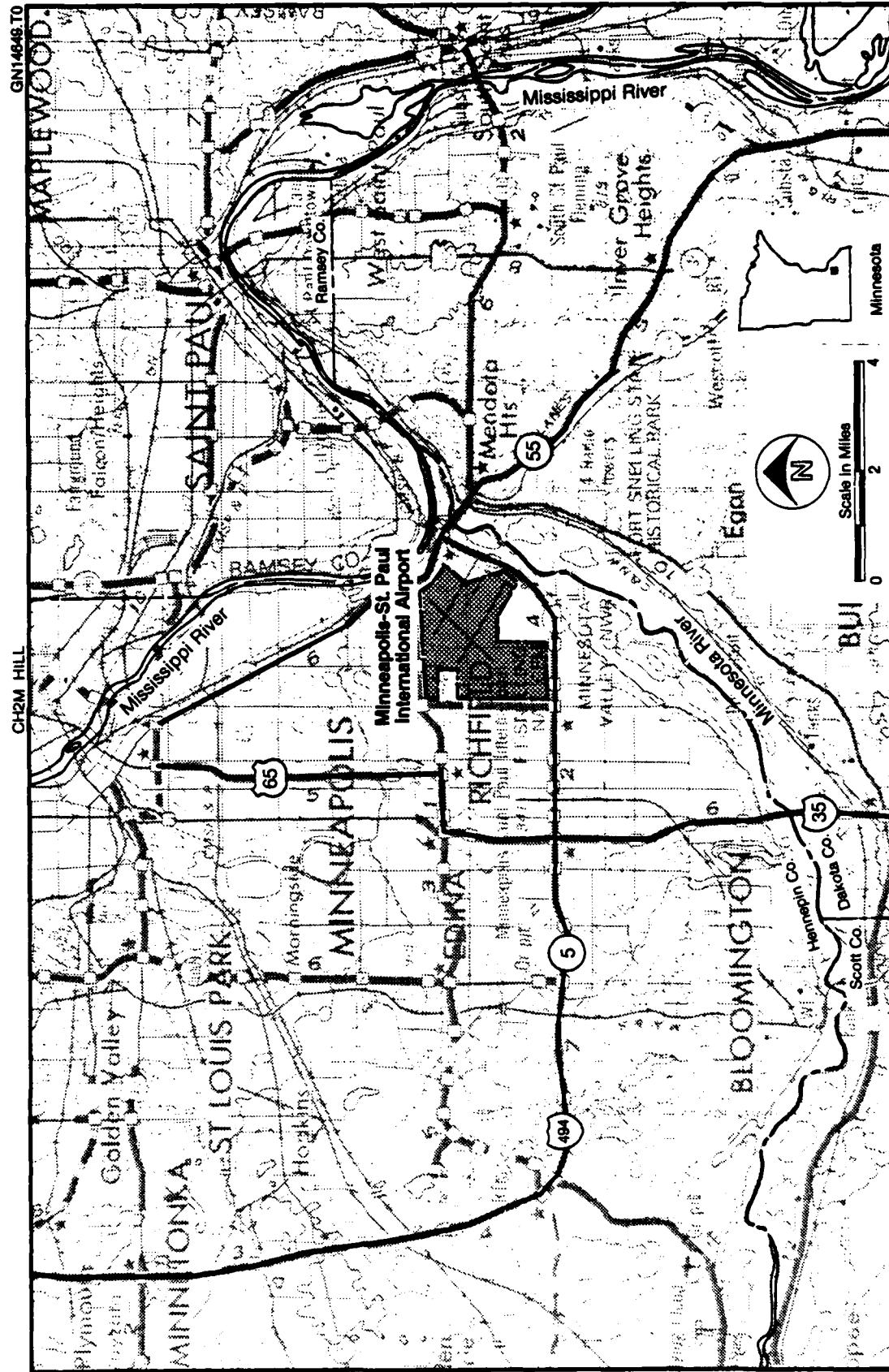


FIGURE 2. Location map of Minneapolis-St. Paul International Airport.

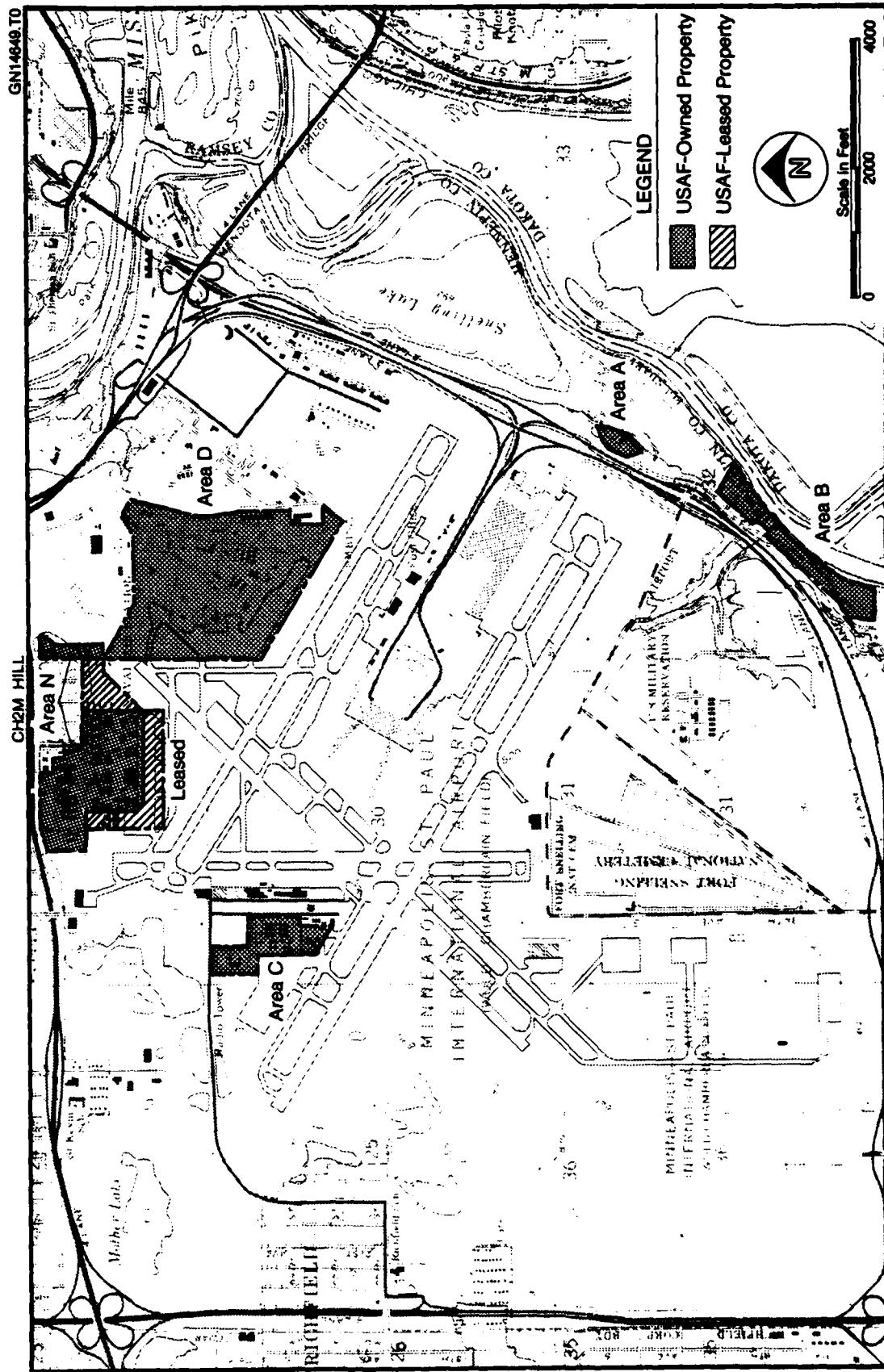


FIGURE 3. Site map of Twin Cities AFRB.

Area D (147.3 Acres): Area D is primarily occupied by the Minnesota Air National Guard. Area D was previously occupied by the USAF from 1952 to 1971, prior to relocating to Area N. The Minnesota Air National Guard relocated to Area D from Area C in 1957. The POL tank farm located in Area D is used jointly by the AFRES and the Minnesota Air National Guard.

Area N (84.79): Area N is primarily occupied by the base host unit, the 934th Tactical Airlift Group (TAG) of the AFRES. This area was the former Twin Cities Naval Air Station from 1923 to its deactivation in 1970. In September, 1971, the 934th TAG obtained approval to consolidate the unit's activities from Areas C and D to Area N. Area N includes a 20.44 acre parcel of land (as shown on Figure 3) which is under lease from the Metropolitan Airports Commission.

B. ORGANIZATION AND MISSION

An Air Force Flight Training Base was established at the Wold Chamberlain Field in 1943. Construction of some facilities began in 1944 in the area now known as Area C. In February of 1952, the Air Defense Command assumed jurisdiction of the installation and initiated a construction program during 1953 and 1954 in the portion of the base now referred to as Area D. In January of 1958, the Continental Air Command (now known as the Air Force Reserve) assumed jurisdiction of the base and the mission changed to reserve training. In 1969, the 934th Tactical Airlift Group became the base host unit and assumed operational and support functions of Twin Cities AFRB.

For several years, the 934th TAG was divided between Areas C and D. In November of 1969, the deactivation of the

Twin Cities Naval Air Station was announced. The Air Force Reserve then acquired the Navy installation to consolidate its activities at one location now referred to as Area N. The final transfer of the Navy property was accomplished in July of 1972.

The primary mission of Twin Cities AFRB has remained relatively unchanged since 1970. The primary mission of the 934th TAG, the base host unit, is to provide command and staff supervision over a "mission" squadron and its support units. This includes a Tactical Airlift Group for air transportation of airborne forces and their equipment and supplies; and material support, including supply services and organizational and field maintenance of assigned aircraft.

There are eight C-130 aircraft assigned to the 934th TAG and an additional eight C-130 aircraft assigned to the Minnesota Air National Guard. The total work force on Twin Cities AFRB numbers approximately 1,220, which includes 820 military, 340 civil service, and 60 non-appropriated fund employees.

The major organization at Twin Cities AFRB are as follows:

- o 934th Tactical Airlift Group, Air Force Reserve
- o 133rd Tactical Airlift Wing, Minnesota Air National Guard
- o Navy Air Reserve
- o Marine Reserve

A more detailed description of the base history and its mission is included in Appendix D.

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III. ENVIRONMENTAL SETTING

A. METEOROLOGY

The climate in the vicinity of Twin Cities AFRB is predominantly the continental type, with wide variations in temperature, ample summer rainfall, and scant winter precipitation. In general, there exists a tendency to extremes in all climatic features. Disturbances originating in the western United States migrate eastward toward the Twin Cities and are often followed by cooler, sometimes much colder, polar air masses from the northwest and north. Meteorological data for the weather station located at the Minneapolis-St. Paul International Airport is summarized in Table 2.

The temperature variation from season to season is quite large. Temperatures range from very warm, though comfortable, due to low daytime humidity in summer, to very cold in winter. Recorded temperature extremes cover a range of 142°F: from 34°F below zero in January 1936 and 1970, to 108°F in July of 1936. There were 36 consecutive days during January-February 1936 when the minimum temperatures were below zero, and 11 consecutive days in July 1948 when the maximum temperature was 90°F or higher. The average date of the last occurrence of a temperature 32°F or lower is April 30. The latest date recorded was May 24, 1925. The average date of the first temperature occurrence of 32°F or lower in autumn is October 13; the earliest date recorded was September 3, 1974. The shortest growing season was 119 days, in 1974, and the longest was 207 days, in 1894 and 1900. The average growing season is 166 days.

The Twin Cities lie near the northern edge of the influx of moisture from the Gulf of Mexico. Severe storms

Table 2
METEOROLOGICAL DATA FOR TWIN CITIES AIR FORCE RESERVE BASE, MINNESOTA

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Annual</u>
Temperature (°F)													
Record High	58	60	83	95	96	100	104	102	98	89	75	63	104
Record Low	-34	-28	-32	2	18	34	43	39	26	15	-17	-24	-34
Normal Daily Maximum	21.2	25.9	36.9	55.5	67.9	77.1	82.4	80.8	70.7	60.7	40.6	26.6	53.8
Normal Daily Minimum	3.2	7.1	19.6	34.7	46.3	56.7	61.4	59.6	49.3	39.2	24.2	10.6	34.3
Normal Mean	12.2	16.5	28.3	45.1	57.1	66.9	71.9	70.2	60.0	50.0	32.4	18.6	44.1
Precipitation (Inches)													
Record Maximum	3.63	2.14	4.75	5.40	8.03	7.99	7.10	9.31	7.53	5.68	5.15	2.21	9.31
Record Minimum	0.11	0.06	0.32	0.59	0.61	1.06	0.58	0.43	0.41	0.01	0.02	1	1
Normal Mean	0.73	0.84	1.68	2.04	3.37	3.94	3.69	3.05	2.73	1.78	1.20	0.89	25.94
Wind													
Mean Velocity (MPH)	10.3	10.5	11.2	12.2	11.2	10.4	9.2	9.1	9.8	10.4	10.9	10.3	10.5
Prevailing Direction	NW	NW	NW	NW	SE	SE	S	S	SE	SE	NW	NW	NW
Thunderstorms													
Mean Per Month	<.5	<.5	1	3	5	8	8	6	4	2	1	<.5	.38

Source: Local Meteorological Data, 1981, Minneapolis-St. Paul, Minnesota (NOAA, 1981).

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such as tornadoes, freezing rain (glaze) and hail, though not frequent, are not uncommon. Five severe tornadoes have struck Minneapolis-St. Paul.

Mean annual precipitation at Twin Cities AFRB averages 25.94 inches per year. During the May-September growing season the normal rainfall is 16.78 inches, approximately 65 percent of the normal mean annual precipitation. Winter snowfall can be heavy and averages more than 40 inches per snow season (equivalent to 4 inches of precipitation). The mean annual lake evaporation rate, commonly used to estimate the mean annual evapotranspiration rate, averages an estimated 29.6 inches per year. Therefore, the annual net precipitation (mean annual precipitation minus mean annual evapotranspiration) for the Twin Cities AFRB area is approximately -3.7 inches per year.

During the winter months humidities are high and sunshine is at a minimum. Observed sunshine during the months of December and January is frequently less than 40 percent of that possible. Fog is infrequent, occurring mainly during late fall, winter, and early spring when a very low cloud cover is more common.

The Minneapolis and St. Paul river terminals mark the end of upstream navigation on the Mississippi River. Since the winter season is long, with daily mean temperatures below freezing from mid-November to late March, the Mississippi River is frozen over at the Twin Cities from approximately December 10 until March 20. Floods occur along the Mississippi River due to spring snowmelt, excessive rainfall, or a combination of both. Occasionally an ice jam forms and creates a local flood condition. The flood problem at St. Paul is complicated by the fact that the Minnesota River empties into the Mississippi River

between the two cities. Consequently, high water or flooding on the Minnesota River creates a greater flood potential at St. Paul. Flood stage at St. Paul can be expected on the average once in every 8 years.

B. GEOLOGY

Twin Cities AFRB, located at the confluence of the Minnesota and Mississippi Rivers, lies in an area which has been modified by glacial ice advances and retreats. The base is located in the Mississippi Valley outwash plain (see Figure 4), which, together with the Cannon Valley and Minnesota Valley outwash plains, forms the Outwash Valley Physiographic Region. This region is characterized by loamy sand and loam with sand and gravel substratum. The region typically consists of nearly level terraces and flood plains along the major rivers and their tributaries.

Adjacent to the Outwash Valley Physiographic Region and occurring across the Minnesota and Mississippi Rivers from the base is the Eastern St. Croix Moraine Physiographic Region. This region consists of a belt of relatively steep hills and relief reflecting its origin of deposition. The Moraine was deposited by advancing glacial ice of what is referred to as the "Superior Lobe". The Moraine consists largely of sandy loam and loam and is underlain by gravel in some areas.

Topography at the airport is relatively flat, sloping eastward toward the river from a maximum elevation of approximately 850 feet above mean sea level (msl) on the west side to approximately 800 feet above msl on the east side. Topography at the installation is flat with the exception of the piece of land adjacent to the Minnesota River where the Small Arms Range is located (Area B). This

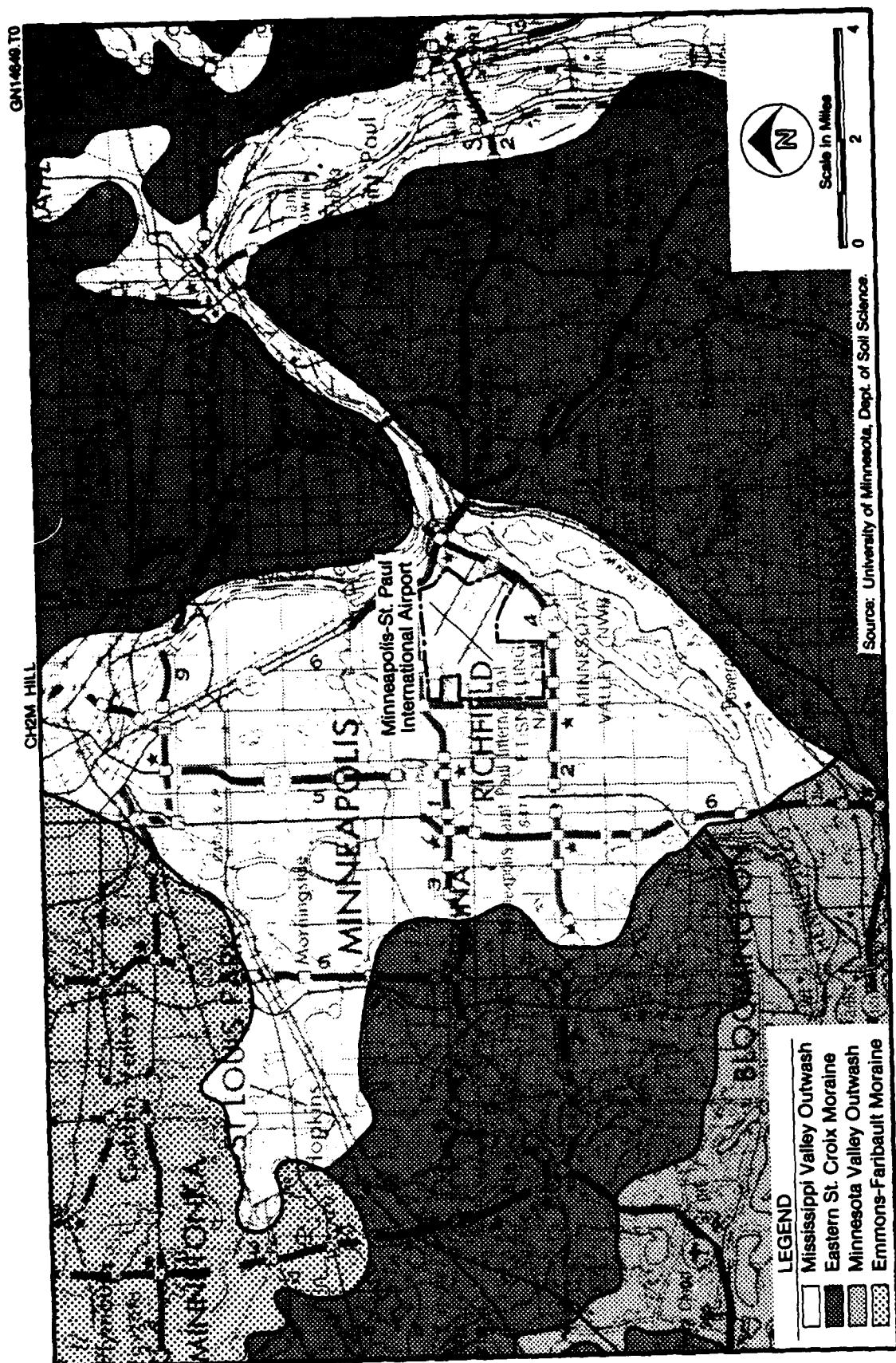


FIGURE 4. Physiographic map.

area is located at the edge of the outwash plain and includes a portion of the river flood plain. In this area relief is quite high (approximately 100 feet).

The elevation along the edge of the outwash plain at this site is approximately 800 feet above msl. The land slopes steeply toward the Minnesota River to the east, to an elevation of approximately 700 feet above msl on the flood plain (see Figure 5).

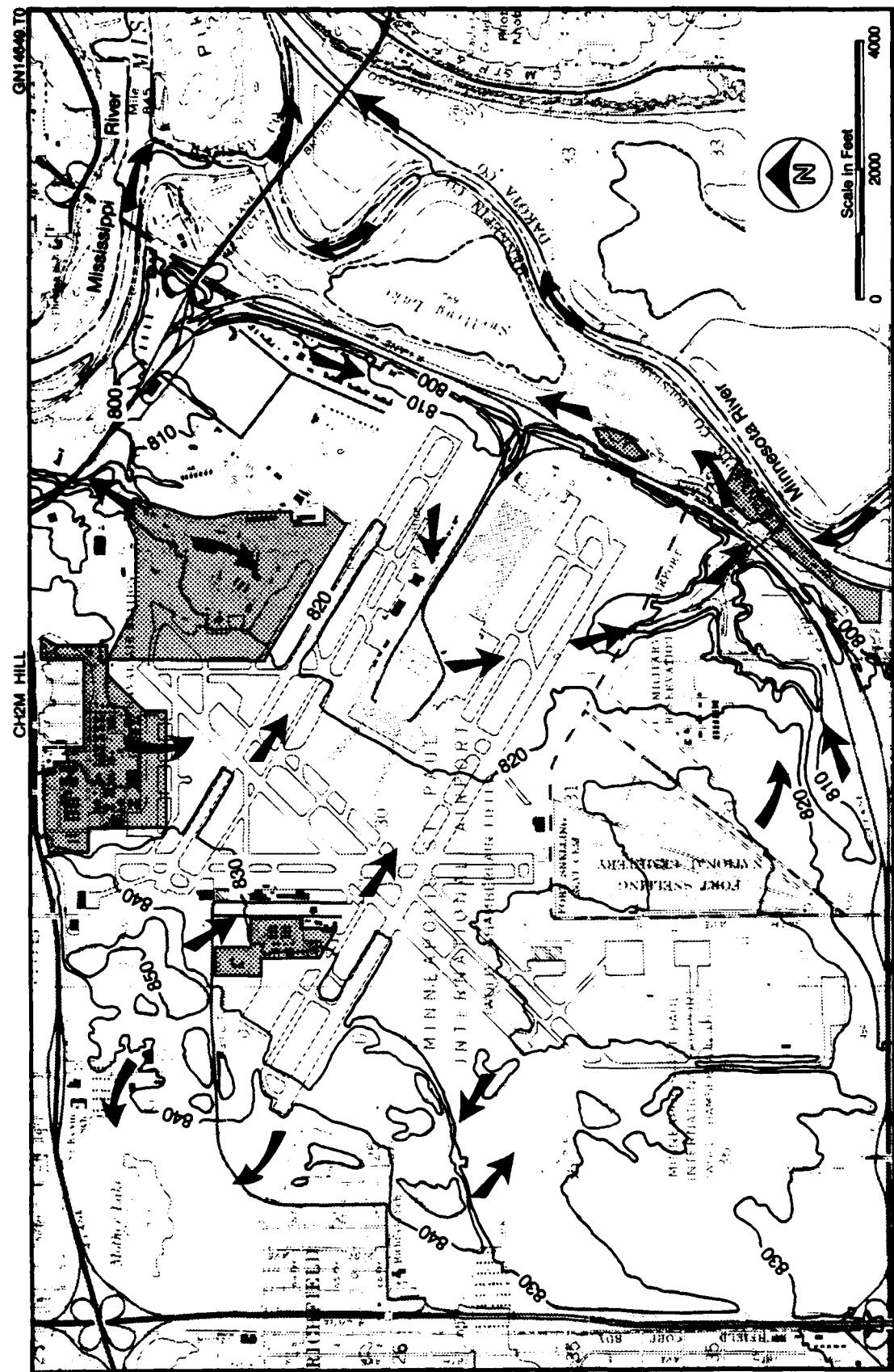
Soils occurring in the study area consist primarily of Dakota, Hubbard, and Estherville series. Soils at the Small Arms Range (Area B) are different, consisting of Chaska and mixed alluvial soil associations. The soil series occurring in the study area are described as follows by the U.S. Department of Agriculture:

The Dakota series consists of well-drained, loamy soils. These soils formed in 22 to 36 inches of loamy alluvium over deep sand. They are nearly level to gently sloping. The native vegetation was tall prairie grasses and mixed hardwoods.

In a representative profile, the surface layer is black loam in the upper 9 inches and dark-brown loam in the lower 5 inches. The subsoil is brown and dark-brown loam about 13 inches thick. The underlying material is stratified, very dark grayish-brown to yellowish-brown and light olive-brown sand.

Dakota soils have moderate to high available moisture capacity, medium internal drainage, and moderately rapid permeability. The water table is at a depth below 5 feet in all seasons and in most places is at a depth below 10 feet.

FIGURE 5. Topography and drainage map of Twin Cities AFRB.



The Hubbard series consists of deep, somewhat excessively drained, sandy soils that formed in sand. These soils occur on topography that ranges from broad flats to steep hillsides. They are mainly on stream and glacial outwash plains. Slopes range from 0 to 35 percent and are mostly simple. The native vegetation was tall prairie grass and a few thin stands of oak and brush.

In a representative profile, the surface layer is loamy sandy about 12 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil is yellowish-brown and brown sand about 28 inches thick. The underlying material is loose, brown and grayish-brown sand.

Hubbard soils have very low available moisture capacity and rapid to very rapid permeability and internal drainage. The water table is usually at a depth below 5 feet in all seasons and in most places, at a depth below 10 feet.

The Estherville series consists of somewhat excessively drained soils that formed in 12 to 24 inches of sandy loam alluvium over calcareous, stratified gravel and sand. These soils are on stream terraces and glacial outwash plains. Slopes range from 0 to 18 percent and include both complex and simple forms. The native vegetation was prairie grass and thin stands of oak and brush.

In a representative profile, the surface layer is very dark brown sandy loam about 12 inches thick that is dark brown in the lower part. The subsoil is dark yellowish-brown sandy loam about 8 inches thick. The

underlying material is calcareous, dark-brown to light olive-brown coarse sandy loam that contains gravel and small amounts of shale.

Estherville soils have a low available moisture capacity because of their shallow depth.

The Chaska series consists of deep, poorly drained soils that formed in deep alluvium. These nearly level soils are in broad, irregularly shaped areas on stream bottom lands. The native vegetation was prairie grasses, sedges, and patches of willow and poplar.

In a representative profile, the surface layer is calcareous, very dark gray clay loam in the upper 10 inches and very dark grayish-brown loam in the lower 23 inches. The underlying material is calcareous, mottled, dark grayish-brown to dark-gray loam that is high in content of very fine sand. Snail shells are present in the lower part of the surface layer and in the underlying material.

Chaska soils have very high available moisture capacity, slow internal drainage, and moderate permeability. These soils are flooded in some years.

Mixed alluvial land consists of moderately well drained, mixed alluvial soils that vary greatly in color, texture, and reaction. These nearly level soils occupy 5-acre to 150-acre tracts on stream bottom lands that are subject to varying frequency of flooding. Many areas are dissected by old stream channels, resulting in short, narrow ridges that have a corrugated appearance. They are continually being changed by additions of new deposits, by scouring, and

by changes in stream channels. The soil material consists of stratified, recently deposited alluvium. There are fairly extensive areas of this land type on the Minnesota River bottom lands, and scattered tracts occur along the Mississippi River and Crow River bottom lands. The native vegetation was bottom-land hardwoods and grass.

The soil material of this land type is too recent for a profile to have formed, but it is faintly to distinctly mottled. Although texture is extremely variable, it is commonly coarse to medium, and there are stratified layers of sand. Along the Minnesota River the sand fraction is dominated by fine and very fine sand, in comparison to fine and medium sand along the Mississippi and Crow Rivers. Reaction ranges from mildly alkaline to moderately alkaline. The water table is at a depth of 2 to 5 feet during wet periods.

The actual occurrence of each specific soil type in the study area cannot be determined since the soil survey for Hennepin County omitted the military bases and the international airport. However, in reviewing the above descriptions it is clear that the main portion of the study area occurring on the flat, low relief outwash plain (Areas C, D, and N) consists of well-drained loamy soils with a water table greater than 5 feet below land surface (bls).

That portion of the study area along the Minnesota River (Area B) consists of poorly drained alluvium with a high water table from 2 to 5 feet bls.

The study area lies within a structural depression known as the Twin Cities Basin. Rocks of Precambrian, Cambrian, and Ordovician age were deposited in a north-south

trending trough in the ancient Precambrian surface. The deepest part of the depositional trough lies directly beneath the cities of Minneapolis and St. Paul. The present land surface is primarily composed of drift from Pleistocene glaciation. In the study area, there is no record of geologic deposition from the late Ordovician to the Quaternary Age (430 million years to 10,000 years ago). These sediment/rock units were removed by glacial erosion processes, and thus are absent from the rock column. Table 3, excerpted from a previous study, lists geologic units which occur below the study area. Only the glacial drift, Platteville Limestone (the Decorah Shale is absent), Glenwood Shale, St. Peter Sandstone, Prairie du Chien Group, and the Jordan Sandstone are of significance with regard to this investigation.

A geologic map of the study area and immediate vicinity illustrates the spatial relationships among these geologic units (see Figure 6).

Surficial deposits within the study area consist primarily of glacial drift consisting of till, outwash sand and gravel, and alluvium. In the study area glacial till overlies the Platteville Limestone. The Decorah Shale, a geologically younger stratum occurring throughout the Twin Cities area, has been eroded away and is absent for the most part in the study area. The Platteville Limestone is a dolomitic limestone. It is this unit which forms the hard cap rock at St. Anthony Falls. The Platteville constitutes the bedrock surface under much of the Twin Cities area as well as the study area. This formation is quarried for limestone in some areas. Within the study area, this

GEOLOGIC UNITS AND THEIR

<u>System</u>	<u>Geologic Unit</u>	<u>Approximate Range in Thickness (in feet)</u>	<u>Description</u>
Quaternary	Undifferentiated glacial drift	0-400+	Glacial till, outwash sand train sand and gravel, lake alluvium of several ages and ages; vertical and horizontal units is complex.
Ordovician	Decorah Shale	0-95	Unconformity Shale, bluish-green to bluish thin, discontinuous beds of limestone throughout formation.
	Platteville Limestone	0-35	Dolomitic limestone and dolomitic hard, thin-bedded to medium shale partings; can be divided members.
	Glenwood Shale	0-18	Shale, bluish-gray to bluish gray, usually soft but becomes dolomitic to the east.
	St. Peter Sandstone	0-150+	Sandstone, white, fine- to well-sorted, quartzose; locally stained and well cemented; frosting of grains is common of siltstone and shale near formation.

^aSource: Water Resources Outlook, 1973.

Table 3

THEIR WATER-BEARING CHARACTERISTICS^a

Description	Water-Bearing Characteristics
sand and gravel, valley-, lake deposits, and es and several proven- horizontal distribution of	Distribution of aquifers and relatively impermeable confining beds is poorly known, especially in subsurface. Where saturated, stratified well-sorted deposits of sand and gravel (alluvium, valley train, outwash, some lake and ice-contact deposits) yield moderate to large supplies of water to wells. Records of 24 large diameter wells completed in sand and gravel show yields ranging from 240 to 2,000 gpm (gallons per minute) with from 2 to 69 feet of drawdown. Des Moines Lobe till is non-water bearing; Superior Lobe till is sandy and may yield small supplies suitable for domestic or farm use.
ormity to bluish-gray; blocky; eds of fossiliferous formation.	Only about 25 square miles in extent in area of study. Confining bed.
nd dolomite, dark-gray, medium-bedded; some be divided into five	Only about 200 square miles in extent in area of study. Where saturated, fractures and solution cavities in rock generally yield small supplies to wells. Records of 23 wells show an average yield of 23 gpm. Water is generally under artesian pressure where overlain by Decorah Shale. Not considered to be an important source of water in area of study.
o bluish-green; gener- dolomitic and harder	Confining bed; locally, some springs issue from the Glenwood-Plateville contact in the river bluffs.
ne- to medium-grained, e; locally iron- nted; rounding and common, 5-50 feet le near bottom of	About 650 square miles in extent in Minnesota part of study area; not fully saturated throughout area. Most wells completed in the sandstone are of small diameter and used for domestic supply. They yield 9 to 100 gpm with 1 to 21 feet of drawdown. Two wells known to be used for public supply have been pumped at 600 and 1,250 gpm. Water occurs under both confined and unconfined conditions. Confining bed near bottom of formation seems extensive and hydraulically separates sandstone from underlying Prairie du Chien-Jordan aquifer. Not considered to be an important source for public supplies in area of study, but is suitable source for domestic supplies.

<u>System</u>	<u>Geologic Unit</u>	<u>Approximate Range in Thickness (in feet)</u>	<u>Description</u>
Prairie du Chien Group	Shakopee Dolomite		Dolomite, light-brown to thickly bedded, cherty; commonly sandy and colit
	New Richmond Sandstone	0-250+	Sandstone and sandy dolomites missing.
	Oneota Dolomite		Dolomite, light-brownish, thinly to thickly bedded
Cambrian	Jordan Sandstone	0-100+	Sandstone, white to yellow, coarse-grained, massive bedded in places; quartz iron-stained; loosely to
	St. Lawrence Formation	0-65	Dolomitic siltstone and dolomitic sandstone, glauconitic.
	Franconia Sandstone	0-200+	Sandstone, very fine grained to highly glauconitic, wavy bedded.
	Ironton Sandstone		Interbedded very fine grained sandstone and shale; mica flakes common.
	Galesville Sandstone	0-80+	Glauconitic fine-grained to buff silty fine-grained sandstone, worm-bored.
	Eau Claire Sandstone	0-150	Sandstone, white, medium grained, poorly sorted and silty.
			Sandstone, yellow to white grained, poorly cemented.
			Sandstone, siltstone, and dolomite, reddish-brown, fossiliferous.

Table 3--Continued

Description	Water-Bearing Characteristics
own to buff, thinly to erty; shale partings; colitic.	About 2,000 square miles in extent in Minnesota part of study area. Together, the Prairie du Chien dolomite and Jordan Sandstone constitute the major aquifer unit in the area. The two are hydraulically connected throughout most of the area, but locally some small head difference may exist owing to intervening low-permeable confining beds of limited extent.
ly dolomite, buff, often	Prairie du Chien: Permeability is due to fractures, joints, and solution cavities in the rock. Yields small to large supplies of water to wells. Pumping rates of up to 1,800 gpm have been obtained.
rownish-gray to buff, bedded, vuggy.	Prairie du Chien-Jordan aquifer: Supplies about 75 percent of ground water pumped in the metropolitan area. Yields of 115 wells (3-24 inch diameter casings), open to both rocks, ranged from 85 to 2,765 gpm with 3 to 133 feet of drawdown. Higher obtainable yields seem to reflect closeness to the Mississippi and Minnesota Rivers or to places where the aquifer is overlain directly by glacial deposits particularly where drift-filled valleys penetrate.
to yellowish, fine- to ssive to bedded, cross- quartzose, commonly ely to well cemented.	Jordan: Permeability is mostly intergranular but may be due to joint partings in cemented parts. Main source of water for public supply in metropolitan area. Almost all wells completed in the sandstone are of large diameter. Recorded yields are from 36 to over 2,400 gpm with 2 to 155 feet of drawdown.
ne and fine-grained ne, glauconitic, in part.	Confining bed. No wells are known to obtain water from this formation.
ine grained, moderately itic, worm-bored in places.	Small amounts of water may be obtainable from the medium- to coarse-grained members of the formation, very little water from the fine-grained members. Not considered to be an important water source in the area of study. Records of wells completed only in the Franconia Formation are lacking.
fine grained sandstone and common.	
grained sandstone and orange -grained sandstone (often	
, medium- to fine-grained, silty.	About 3,000 square miles in extent in area of study. An important aquifer beyond the limits of the Prairie du Chien-Jordan aquifer. Yields of wells range from 40 to 400 gpm with 4 to 110 feet of drawdown.
to white, medium- to coarse- emented.	Confining bed. Sandstone beds may yield small quantities of water to wells for domestic use. Shale of very low permeability and apparent large areal extent constitutes the main confining bed for water in the underlying aquifer.
one, and shale, gray to ssiliferous.	

Table

<u>System</u>	<u>Geologic Unit</u>	<u>Approximate Range in Thickness (in feet)</u>	<u>Description</u>
Cambrian (Cont.)	Mt. Simon Sandstone	As much as 200	Sandstone, gray to pink, fine-grained. Some pebble zones.
Precambrian	Hinckley Sandstone	As much as 200	Unconformity Sandstone, buff to red, fine-grained, well sorted and
	Red clastics	As much as 4,000	Unconformity Silty feldsparthic sandstone, fine-grained; probably shale.
	Volcanic rocks	As much as 20,000	Unconformity Mostly mafic lava flows, with interlayers of tuff and breccia.

Table 3--Continued

Description	Water-Bearing Characteristics
pink, medium- to coarse-grained zones and thin, shaly intercalations	Secondary major aquifer in the area of study. Supplies about 15 percent of ground water pumped in the metropolitan area. Recorded yields of 27 municipal and industrial wells ranged from 115 to 1,100 gpm with 20 to 209 feet of drawdown. Major source of artesian water in northern half of study area.
red, medium- to coarse-grained and cemented.	Aquifer of local interest in Chisago County, T.35 M., R. 21 W. Wells have yields from 15 to 120 gpm with 41 to 150 feet of drawdown. Data are lacking in metropolitan and other parts of area.
sandstone and lithic sandstone; probably included red intercalations	Rock is at and near the surface at Taylor Falls and north of boundary of study area. Weathered or fractured zones provide small quantities of water for domestic needs. Deeply buried in metropolitan area and no data available.
flows, but includes thin lenses of sand and breccia.	

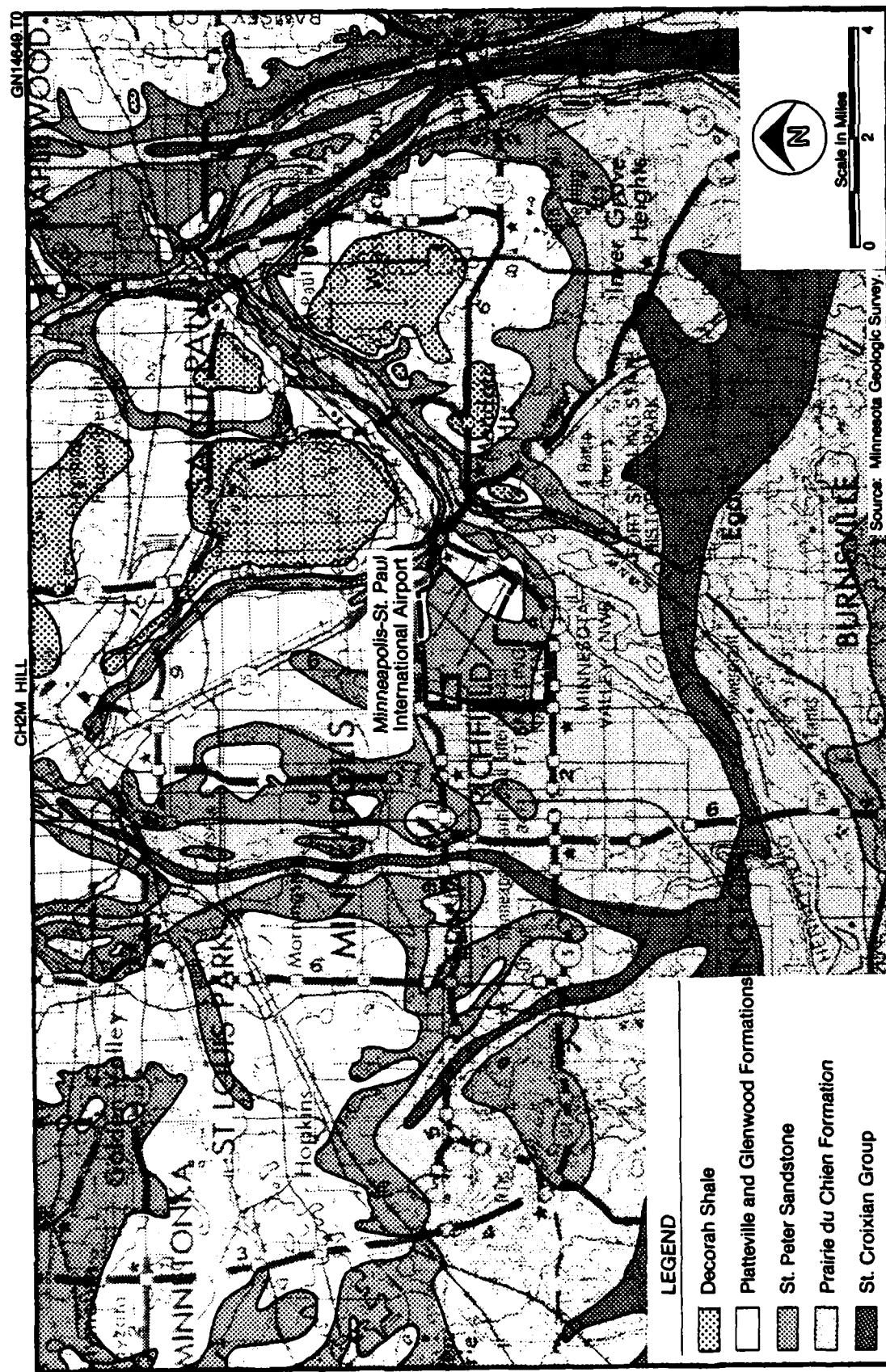


FIGURE 6. Geologic map.

formation is only 3 to 5 feet in thickness and occurs from 10 to 15 feet bls.

The Platteville Limestone is underlain by a thin stratum of blue-gray rock known as the Glenwood Shale. This formation represents a depositional transition between limestone (quiet, very deep water) and sandstone (high energy, shallow water) and occurrence and thickness are somewhat variable.

The St. Peter Sandstone underlies the Glenwood Shale (or if the Glenwood Shale is absent, the Platteville Limestone) and consists of a white, fine to medium-grained well-sorted quartz sandstone for the most part. The formation is also typified by the occurrence of siltstone and shale, again a depositional transition, at the base. The St. Peter Sandstone is quite friable and highly erodable. The combination of a soft, friable sandstone (St. Peter) capped by a resistant layer of limestone (Platteville) has resulted in some unique geologic features in the Twin Cities Area. Falls, such as St. Anthony Falls, have resulted from the action of streams/rivers on two different geologic units; streams/rivers erode the resistant limestone very little, but at the edge of this unit the St. Peter Sandstone is encountered and the stream/rivers easily begin to cut a deep channel, resulting in a falls that point. The falls then move upstream as the swirling action of the water undercuts and erodes the soft sandstone. Also of significance in the Twin Cities area are the many caves, both natural and man-made, occurring within the St. Peter Sandstone, the roof of the cave being the Platteville Limestone. Also of interest, the St. Peter Sandstone, valued for its high purity silica, was once mined beneath the Ford Plant for use in making auto glass.

Occurring beneath the St. Peter Sandstone is the Prairie du Chien Group consisting of the Shakopee-New Richmond-Oneota Formations. The Shakopee, which constitutes the upper third of the formation, is composed of shaly dolomite and is the most important source of crushed rock in the area. The New Richmond consists of sandstone and sandy dolomite and is often missing. The Oneota consists primarily of dolomite.

The Jordan Formation, a massive quartz sandstone unit, occurs immediately below the Prairie du Chien Group. The Jordan Formation resembles in appearance the younger St. Peter Sandstone and is also a source of silca used for glass making.

The log from the deep well located in Building 804 is illustrated in Figure 7. The driller's log was obtained from the base soil boring plan. The geologic units illustrated on this figure are interpretations from the log.

C. HYDROLOGY

The study area is located at the confluence of two major surface-water courses: the Mississippi and the Minnesota Rivers. Only a small portion of the study area (the Small Arms Range, Area B) is within the flood plain and is therefore greatly impacted by the present flow regime. Most of the drainage from the main base areas discharges to the Minnesota River and in turn to the Mississippi River (see Figure 5). Drainage from the main portion of the base is in an easterly direction toward the river. There are no surface-water bodies or natural watercourses on-base, and drainage occurs through man-made ditches and storm sewers.

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GEOLOGIC UNIT	DRILLER'S LOG	Depth in Feet
		0
Glacial Drift	Sand & Clay	13
	Sand	18
	Hardpan	29
Platteville Limestone	Clay & Rocks	56
Glenwood Shale	Blue Clay	80
	Hard Sandy Clay	110
St. Peter Sandstone	Sandrock	175
	Sandrock & Shale	224
Prairie du Chien Group	Shakopee Dolomite	350
Jordan Sandstone	Jordan Sandrock	410
	Jordan Sandrock Shale	446

FIGURE 7. Geologic log from the deep well located in Building 804.

The water quality classifications of river segments located at the boundary of the Twin Cities AFRB study area are presented in Appendix E. Also provided in Appendix E is an explanation of the Minnesota water quality classifications and some representative water quality data.

Approximately 140 million gallons per day (mgd) of surface water is used in the metropolitan area. Ground-water sources account for an additional 200 mgd within the Twin Cities area. Therefore, both ground water and surface water represent important sources of water supply within the Twin Cities area.

The base obtains all of its water from the City even though abundant supplies exist on-base.

Several distinct hydrologic units underlie the study area including the St. Peter Aquifer, Prairie du Chien-Jordan Aquifer, Franconia-Ironton-Galesville Aquifer, and the Mt. Simon-Hinckley-Fond du Luc Aquifer. For purposes of this investigation, only the upper two aquifers, the St. Peter and the Prairie du Chien-Jordan, are considered (see Figure 8). Wells in the vicinity rarely penetrate below the Jordan Sandstone of the Prairie du Chien-Jordan Aquifer (depth of approximately 500 feet at the base), because adequate water supplies can be obtained from these hydrologic units.

The St. Peter Aquifer, occurring at a depth of approximately 70 to 80 feet bsl at the base, is capped by the Decorah-Platteville-Glenwood confining bed. This stratum in the study area consists of a massive, fractured limestone and shale units. In some areas, possibly on-base, the overlying confining beds have been removed by erosion and thus the St. Peter Aquifer lies directly beneath glacial drift or

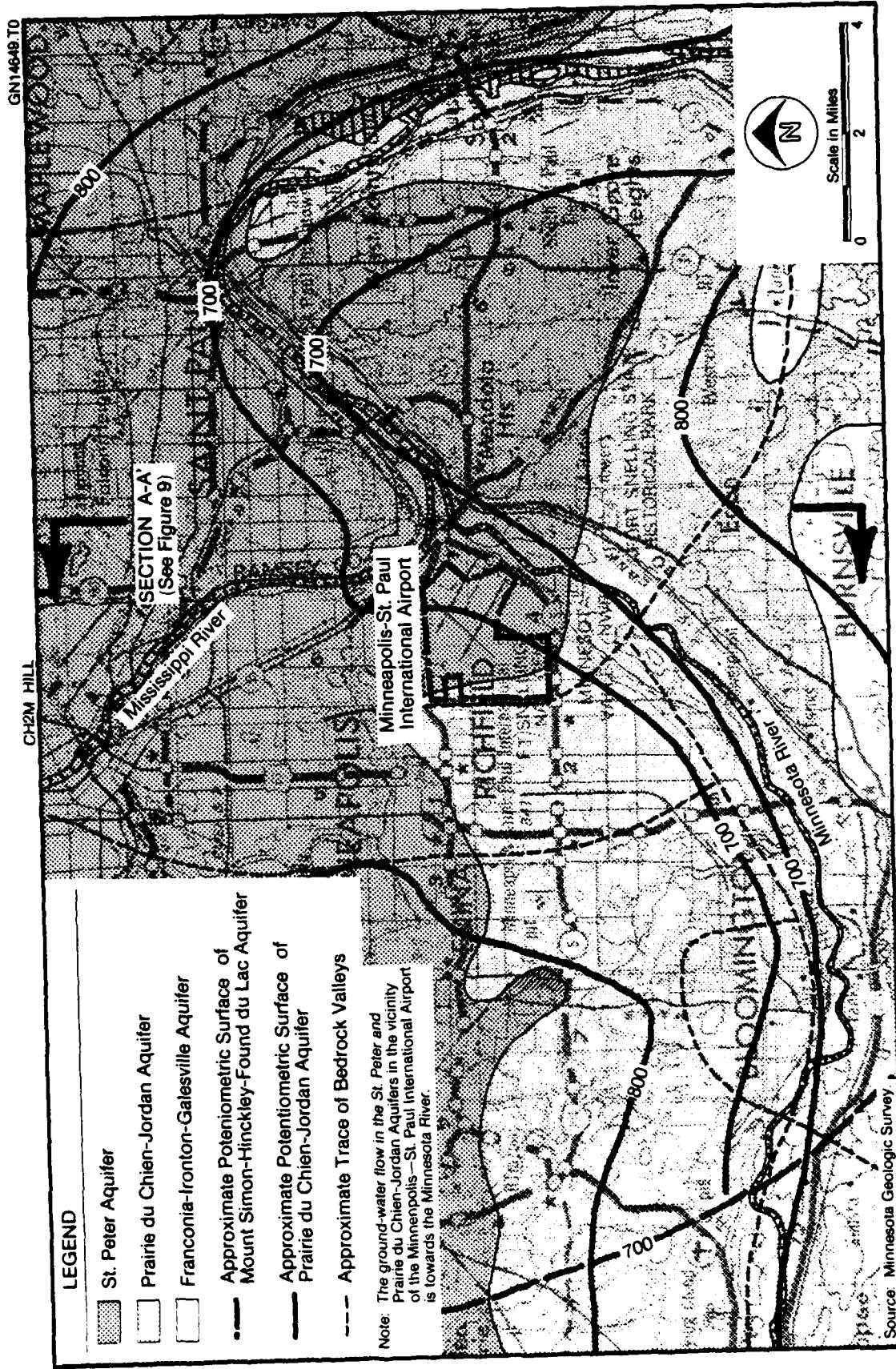


FIGURE 8. Hydrogeologic map.

outcrops at the surface. The aquifer is confined at its base by thin beds of siltstone and shale. In the study area the St. Peter Aquifer dips at approximately 10 feet/mile toward the center of the Minneapolis-St. Paul urban area (see Figure 9). At the base, the St. Peter Sandstone is approximately 140 feet thick, and flow is to the east toward the rivers. Water levels within the aquifer range from approximately 85 to 120 feet bls. Since the top of the aquifer is approximately 80 feet bls, the aquifer is partially dewatered at times. Recharge to the aquifer locally is by infiltration in areas of outcrop or where the confining bed is absent. Discharge is to the Minnesota or Mississippi River in the study area. This aquifer is used very little for water supply in the vicinity of the base.

The Prairie du Chien-Jordan Aquifer is a major regional aquifer in the Twin Cities area. This aquifer lies beneath the St. Peter Aquifer and is confined by the silt-shale basal strata of this formation.

The Prairie du Chien-Jordan Aquifer consists of two geologic units, limestone-dolomite and sandstone, which act as a single hydrologic unit. This aquifer also dips to the center of the Minneapolis-St. Paul urban area at approximately 10 feet/mile. Within the study area, the Prairie du Chien-Jordan Aquifer also flows toward the east; however, the aquifer does not discharge to the river. Recharge to this aquifer occurs through river channels which cut through the confining layer of the St. Peter Aquifer and by way of karst features (sinkholes, solution channels) created by erosion within the carbonate units of the Prairie de Chien Group. Ground-water quality from both the St. Peter and the Prairie du Chien-Jordan Aquifers is excellent (less than 500 ppm total dissolved solids) in the study area.

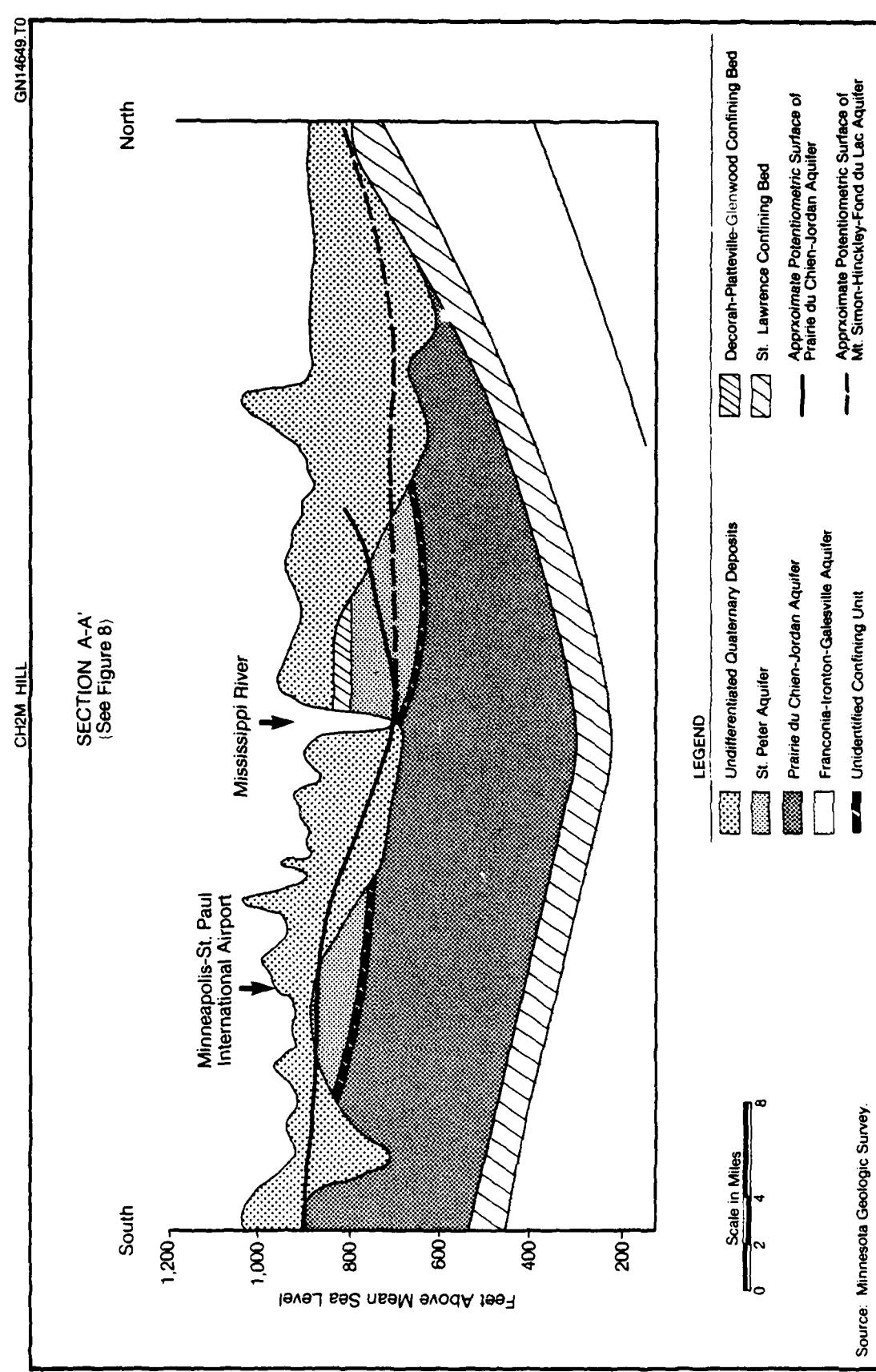


FIGURE 9. Hydrogeologic Cross Section A-A'.

Geologic and hydrogeologic conditions at the base are such that ground-water and surface-water contamination are possible.

At the main area of the base (Areas C, D, and N) the upper 70 to 80 feet of sediments are unsaturated. A contaminant placed on the surface would probably infiltrate vertically into the soils until it reached low-permeability soils above the Platteville Limestone. The contaminant would then likely move horizontally toward a drainage ditch or the river. The uppermost aquifer is also capped with a low-permeability shale unit. There would be only a slight chance that a contaminant placed on the surface would reach the little-used St. Peter Aquifer and almost no chance of its reaching the widely used Prairie du Chien-Jordan Aquifer. This assumes that there are no direct pathways to the aquifer(s) via faulty well casings, etc.

The portion of the base located on the river flood plain (Small Arms Range, Area B) should be considered differently than the main portion of the base. In this area the water table is within 10 feet of land surface. Here, the confining beds of the Platteville, Glenwood, and probably the St. Peter are absent. A contaminant on the surface here would migrate quickly to the water table and move generally toward the east discharging to the Minnesota River.

D. ENVIRONMENTALLY SENSITIVE CONDITIONS

1. Biota

Nine different major plant communities are native to the Minneapolis-St. Paul metropolitan area. Upland forest types include the white oak community, northern pin

oak community, and maple-basswood community, all of which characteristically occur on well-drained loamy or sandy soils. The upland prairie community is typically devoid of trees and occurs on excessively drained sandy soils. The oak savannah community also occurs on excessively-drained sandy soils and represents a transitional community between the upland prairies and mixed hardwood forests.

Forest lowlands in the Minneapolis-St. Paul area include the bottomland hardwood community along the Mississippi and Minnesota River flood plains and the cedar-tamarack community in non-riverine depressions. The steep slope forest community occurs along river bluffs adjoining major river flood plains, its vegetative composition varying according to slope steepness, soil, drainage, bedrock, and especially orientation of slope. Fresh marsh wetlands are common in the region both in upland depressions and along portions of major river flood plains. With the exception of the steep slope and bottomland hardwood communities adjoining the Minnesota and Mississippi Rivers, the plant communities on and around Twin Cities AFRB are either ornamental, early successional, or remnants of the historic natural forest and prairie lands.

One minor wetland plant community in the Minneapolis-St. Paul area which is considered to be critically endangered is the calcareous fen. Calcareous fens are rare in Minnesota, with a total known acreage of less than 500 acres. The Black Dog Fen, located 8 miles southwest of the AFRB, contains seven plant species which are proposed as either state threatened or state special concern.

Although no creeks, lakes, or watercourses actually occur on Twin Cities AFRB property, the base is

located close to a number of significant aquatic habitats. These include Mother Lake and associated marsh wetlands to the west of the base; the Mississippi River to the northeast; and Snelling Lake, the Minnesota River, and associated wetlands to the east and south. Recent fish sampling by the Minnesota Department of Natural Resources in the lower Minnesota River revealed a number of recreationally important fish species, including walleye, sauger, shovelnose sturgeon, white bass, northern pike, and channel catfish (Renard, personal communication, 1982). It should be noted that a health advisory regarding high PCB levels in fish tissue is in effect for both the Minnesota and Mississippi Rivers in the vicinity of Twin Cities AFRB (Enblom, personal communication, 1982), though the AFRB is not a known or suspected source of PCB.

In the immediate vicinity of the Twin Cities AFRB, the lower Minnesota River flood plain (most of which is in either Fort Snelling State Park or the Minnesota Valley National Wildlife Refuge) is utilized by 24 species of waterfowl and is a very productive breeding/nesting area. Five heron-egret nesting colonies are located within 10 miles of the AFRB, including a colony at Gun Club Lake, 2.5 miles south-southwest of AFRB (Coffin, 1982). Both Fort Snelling State Park and the Minnesota Valley National Wildlife Refuge occur in close proximity (within 1 mile) of portions (Areas A and B) of the AFRB.

Coffin (1982) lists two colonial nesting sites of Forster's tern (Sterna fosteri) within five miles of Twin Cities AFB. One site on Wood Lake, located approximately 4 miles west-southwest of the AFRB, contained 100 nests in 1977. The second site, containing an estimated 70 nests in 1981, is located in the marshes adjoining Mother Lake, one

mile directly west of the AFRB. Forster's tern has been proposed as a state species of special concern.

2. Endangered Species

Only three species listed as endangered or threatened by the U.S. Fish and Wildlife Service are known to occur in the Minneapolis-St. Paul Metropolitan area. Bald eagles (Haliaeetus leucocephalus), considered to be threatened in Minnesota, periodically migrate through the area and overwinter along portions of the major rivers (Dodge et al., 1966; Embлом, 1982). The endangered artic peregrine falcon (Falco peregrinus tundrius) also migrates through the area in the spring and fall during the peak waterfowl migration period (Leach, 1982; Hickock and Associates, 1977). Several recently published reports indicate the presence of this species in the lower Minnesota River flood plain, though no nesting occurs. The endangered Higgin's eye pearly mussel (Lampsilis higginsi) has been collected recently in Lake St. Croix and the lower Minnesota River (Hickock and Asscciates, 1977). It may also exist in cleaner portions of the Mississippi River.

A list of Minnesota animals and plants in need of special consideration, with suggestions for management, was compiled by the Minnesota Department of Natural Resources in 1974, though these species have not yet received official state status. Based on work by Moyle (1975), Hickock and Associates (1977), Morley (1972), Hughes (1974), and Coffin (1982), none of these proposed species are known to occur on the AFRB.

3. Environmental Stress

During ground tours and a helicopter overflight of Twin Cities AFRB, no significant environmental stresses related to hazardous wastes were observed. With the exception of herbaceous vegetation kills along fencelines in the vicinity of Building 616, which are attributable to herbicide application, the only observed vegetation effects were due to physical/soil disturbance at landfills and other sites.

IV. FINDINGS

IV. FINDINGS

A. ACTIVITY REVIEW

1. Summary of Industrial Waste Disposal Practices

The major industrial operations at Twin Cities AFRB include corrosion control shops, flightline maintenance shops, inspection sections, propulsion shops, pneumdraulics shops, aerospace ground equipment (AGE) maintenance shops, non-destructive inspection (NDI) labs, and vehicle maintenance shops. These industrial operations generate varying quantities of waste oils, contaminated fuels, and spent solvents and cleaners.

The total quantity of waste oils, contaminated fuels, and spent solvents and cleaners generated by all the organizations at Twin Cities AFRB is estimated to range from 10,000 to 15,000 gallons per year. The above range of total waste quantities is believed to be representative of the period from the late 1950s, when the mission changed to Reserve training, to present.

a. 934th TAG

Industrial operations conducted by the Air Force have been in existence since the 1940s. Construction of the Air Force installation began in approximately 1944 and additional construction programs were conducted during 1951. The Air Force originally had locations in Areas C and D and then relocated to Area N in 1971. Since 1971, the 934th TAG industrial activities have been conducted at their present locations in Area N. Prior to 1971, the activities were conducted in Building No. 1 (P-1 Hanger), located in Area C, and in Buildings No. 670, 680, and 685, located in

Area D. Standard procedures for past (based on information obtained from shop files and on the best recollection of interviewees) and present industrial waste disposal practices are as follows:

- o 1943 to 1975: Prior to 1975, there was no program of waste segregation. Waste oils, spent solvents, and some contaminated fuels were commingled and collected in 55-gallon drums. The drums were stored outside the various industrial shops until the quantity was sufficient for a contractor to pump out the contents. The contractor then transported the wastes off the installation. The majority of contaminated fuels were collected in drums and bowsers and transported to the Fire Department Training Area located on the Metropolitan Airports Commission property to be used for training exercises. Some contaminated fuels and waste oils were used as supplemental fuel in the heating plant located in Area C.
- o 1975 to 1981: Waste oils, spent solvents, and contaminated fuels were segregated into separate 55-gallon drums. The waste oils and spent solvents were either pumped out by a contractor and transported off the installation or were transported by base personnel to the Defense Property Disposal Office (DPDO) located at Duluth AFB, Minnesota. Contaminated fuels were used for fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area. Some contaminated fuels and waste oils were used as supplemental fuel in the heating plant located in Area C.

- 1981 to Present: Waste oils are collected in 55-gallon drums and stored at one of two Recoverable and Waste Products Accumulation Points (located outside Buildings 803 and 822). Waste oils are transported by base personnel to DPDO for salvage, or DPDO issues a contract for the removal of the waste oil. Waste oils from the AGE Maintenance Shop are used as supplemental fuel in the heating plant in Area C. Spent solvents are collected in 55-gallon drums and are transported to the Hazardous Waste Storage Facility for temporary storage. DPDO accepts accountability of the spent solvents, but not physical custody. When a sufficient number of drums accumulate, DPDO issues a contract for the removal of the drums. Contaminated fuels are used for fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area.

b. Minnesota Air National Guard

Industrial operations conducted by the Air National Guard have been in existence since the early 1950s. The Air National Guard was originally located in Area C and then relocated in Area D in 1957. The majority of the Air National Guard industrial activities have been conducted at their present locations in Area D since 1957. Those industrial shops, currently located in Building No. 687, were previously located in Buildings No. 680 and 685 prior to 1978. The Motor Pool, currently located in Building No. 662, was located in Building No. 614 prior to 1977. Prior to 1957, all activities were conducted in Area C. Standard procedures for past (based on the best recollection of interviewees) and present industrial waste disposal practices are as follows:

- o 1951 to 1975: Prior to 1975, there was no program of waste segregation. Waste oils, spent solvents, and some contaminated fuels were commingled during collection. From 1951 to 1970, the commingled wastes were collected in 55-gallon drums, with the exception of the Motor Pool, which had a 250-gallon underground tank located outside Building No. 614 for its wastes. From 1970 to 1975, the commingled wastes were collected in drums and then transferred to one 5,000-gallon underground tank located at the extreme northwest corner of Area D where Areas D and N connect. The commingled wastes were then pumped out by a contractor and transported off the installation. Some commingled wastes were transported to Camp Riley (an Air National Guard Training Camp located in Little Falls, Minnesota) where the wastes were used for road oiling to control dust on unimproved roads. Contaminated fuels were used for fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area. Some contaminated fuels and waste oils were used as supplemental fuel in the heating plant located in Area C.
- o 1975 to Present: Waste oils and PD 680 are segregated from spent solvents. However, the waste oils and PD 680 are not segregated into individual components such as synthetic oil, hydraulic fluid, engine drain oil, etc. The waste oils are collected in 55-gallon drums, with the exception of the Motor Pool, which has a 250-gallon underground tank located outside its new facility at Building No. 662. The waste oils are then pumped out by a contractor and transported off the installation. The spent

solvents are collected in 55-gallon drums, which are turned over to Supply and are then transported by base personnel to DPDO located at Camp McCoy, Wisconsin. Contaminated fuels are used for fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area.

c. Navy Air Reserve and Marine Reserve

Industrial operations conducted by the Navy have been in existence since the early 1930s. The industrial operations were conducted at the Twin Cities Naval Air Station, which is now referred to as Area N. The Twin Cities Naval Air Station was deactivated in 1970. Detailed information pertaining to the types of industrial activities conducted at the Naval Air Station was not available. The Navy Air Reserve and Marine Reserve now have locations in Area C (Buildings No. 1 and 2, respectively). The industrial activities presently conducted in Area C are relatively minor compared to those conducted by the 934th TAG and Minnesota Air National Guard. There are no aircraft assigned to the two tenants in Area C. Standard procedures for past (based on the best recollection of interviewees) and present industrial waste disposal practices are as follows:

- o Prior to 1970 (Twin Cities Naval Air Station active during this period): There was no program of waste segregation. Waste oils, spent solvents, and some contaminated fuels were commingled and collected in 55-gallon drums, which were then transferred to a 5,000-gallon underground tank located where Areas D and N connect. This is probably the same underground tank used by the Minnesota Air National Guard from 1970 to 1975.

The commingled wastes were then pumped out by a contractor and transported off the installation. Contaminated fuels were used for fire department training exercises at the Metropolitan Airports Commission Fire Department Training Area.

- 1970 to Present: During the period from 1970 to 1979, industrial activities were relatively limited. During this period, primarily waste oils and spent solvents were collected in 55-gallon drums and stored in Building No. 1 (P-1 Hanger). The waste oil and spent solvent drums were allowed to accumulate and in 1979, approximately 40 drums were removed by a contractor. In 1979, industrial activities were slightly accelerated when a project to remove the preservative from guns in storage was initiated. Waste oils are presently collected in 55-gallon drums and removed by a contractor. Some waste oils are transported to DPDO at Camp McCoy, Wisconsin. Spent solvents, primarily PD-680, are collected in 55-gallon drums and removed by a contractor.

2. Industrial Operations

The industrial operations at Twin Cities AFRB are primarily involved in the routine maintenance of C-130 aircraft. Appendix E contains a master list of the industrial operations.

A review of base records and interviews with past and present base employees resulted in the identification of the industrial operations in which the majority of industrial chemicals are handled and hazardous wastes are generated. Table 4 summarizes the major industrial

Table 4
MAJOR INDUSTRIAL OPERATIONS SUMMARY

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— = Time frame confirmed by shop personnel.
- - - = Time frame assumed by shop personnel.

DPDO = Defense Property Disposal Office (inc

Prior to 1971, the 934th TAG activation contractor removal is off-base.

Building No. 1 of Area C, and Building No. 670, 680, and 685 of Area D.

All contractor removal is off-base.

Table 4--Continued

Shop Name	Location (Bldg. No.)	Waste Material	Estimated Waste Quantity	Treatment/Storage/Disposal Methods			
				1940	1950	1960	1970
Corrosion Control Shop--Continued	813	Waste acids	28 gal/yr			Neutralization to sanitary sewer	
		Paint filters	80 lb/yr			Dumpster Contractor removal	DPDO
		Magnusol 747 PD 680	150 gal/yr			Diluted to oil/ water separator To sanitary sewer	
Fuel Cell Maintenance Shop	870		a			Diluted to oil/ water separator To sanitary sewer	
		Magnusol 747				Diluted to storm sewer	
		PD 680	50 gal/yr			Diluted to storm sewer	
Flightline Maintenance Shop	821	Ethyleneglycol	750 gal/winter			Diluted, runoff to storm sewer	
		Engine oil				Contractor removal	DPDO
		Magnusol 747	200 gal/yr			Contractor removal	DPDO
Inspection Section	21		a			Diluted to storm sewer	
						Diluted to oil/ water separator To sanitary sewer	

LEGEND

— = Time frame confirmed by shop personnel.

- - - = Time frame assumed by shop personnel.

DPDO = Defense Property Disposal Office (includes: ~~DPDO~~, redistribution and marketing facility).

^aMagnusol 747 waste quantity included in Corrosion Control Shop inventory; aircraft washing conducted in Buildings No. 870 and 821.
All contractor removal is off-base.

Table 4--Continued

Shop Name	Location (Bldg. No.)	Waste Material	Estimated Waste Quantity	Treatment/Storage/Disposal Methods				
				1940	1950	1960	1970	1980
NDI Lab	822	Biodegradable penetrant Developer Glacial acetic acid	55 gal/3 yr 60 gal/yr 40 gal/yr			Sanitary sewer		
		Fixer	60 gal/yr		Silver recovery at base photo lab to sanitary sewer			
		PD 680			Contractor removal; DPDO			
Battery Shop	822	Battery acid	30 gal/3 yr 12 gal/yr		Contractor removal; DPDO			
		Pneudraulics Shop	50 gal/yr 80 gal/yr		Neutralization to sanitary sewer			
	822	Hydraulic fluid PD 680			Contractor removal; DPDO			
Propeller Shop	822	Hydraulic fluid	150 gal/yr		Contractor removal; DPDO			
Repair and Reclamation Shop	822	PD 680	100 gal/yr		Contractor removal; DPDO			
Motor Vehicle Maintenance Shop	803	Hydraulic fluid Engine oil PD 680	10 gal/yr 600 gal/yr 60 gal/yr		Supplemental fuel in Area C heating plant			
		Battery acid	120 gal/yr		Neutralization to sanitary sewer			
		Ethylene glycol	250 gal/yr		Sanitary sewer			

LEGEND

- = Time frame confirmed by shop personnel.
- - - = Time frame assumed by shop personnel.
- DPDO = Defense Property Disposal Office (includes former redistribution and marketing facility).

^aAll contractor removal is off-base.

Table 4--Continued

Shop Name	Location (Bldg. No.)	Waste Material	Estimated Waste Quantity	Treatment/Storage/Disposal Methods
Minnesota Air National Guard ^a				
Flightline Maintenance Shop	680	Hydraulic fluid Synthetic engine oil	250 gal/yr	Contractor removal ^b
Corrosion Control Shop	687	NEK Toluene	100 gal/yr	Contractor removal
Phase Inspection Dock		Paint filters and sludge	20 gal/yr	Landfill
Environmental Systems Shop	685	Hydraulic fluid Engine drain oil	200 gal/yr	Dumpster contractor removal
Pnedraulics Shop	687	JP-4	Unknown	Contractor removal
Propulsion Shop	687	Bromochloromethane	10 gal/yr	DPDO
NDI Shop	687	PD 680 Hydraulic fluid Synthetic engine oil Hydraulic fluid PD 680 MEK Paint stripper	60 gal/yr 50 gal/yr 600 gal/yr 12 gal/yr 6 gal/yr	Contractor removal ^b

LEGEND

Time frame confirmed by shop personnel.

-- - = Time frame assumed by shop personnel.
DPDO = Defense Property Disposal Office (includes

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^aPrior to 1957, all Minnesota Air National Guard contractor removal is off-base.

Table 4--Continued

Shop Name	Location (Bldg. No.)	Waste Material	Estimated Waste Quantity	Treatment/Storage/Disposal Methods
Surface Transportation/Motor Pool	662	Engine drain oil PD 680 Paint thinner Trichloroethane	500 gal/yr	Contractor removal a
Battery Shop	662	Battery acid	25 gal/yr	Neutralization to leaching pit
Navy Air Reserve ^b	P-1	PD 680	2,400 gal/yr	Neutralization to sanitary sewer
Ordnance Shop	P-1	Paint sludge	50 gal/2 yrs	Contractor removal
Ground Support Shop				Contractor removal

LEGEND

— = Time frame confirmed by shop personnel.

- - - = Time frame assumed by shop personnel.

DPDO = Defense Property Disposal Office (includes former redistribution and marketing facility).

^aAll contractor removal is off-base.^bPrior to deactivation in 1970, the Twin Cities Naval Air Station was located in Area N.

operations and includes the estimated quantities of wastes generated as well as the past and present disposal practices of these wastes, i.e., treatment, storage, and disposal. Those industrial operations which are listed in Appendix E but are not discussed in this section are considered to be insignificant hazardous waste generators. Information on estimated waste quantities and past disposal practices is based upon information obtained from shop files and interviews with shop personnel based upon their best recollection. Descriptions of the major industrial activities are included in the following paragraphs. Refer to Table 4 for the past and present disposal practices.

a. 934th TAG

i) AGE Maintenance Shop

The AGE Maintenance Shop is located in Building No. 820. The responsibility of this shop is to repair, maintain, and periodically inspect all aerospace ground equipment including auxiliary power units, heaters, and hydraulic test stands, and compressed air equipment for assigned and transient aircraft. Wastes generated include commingled engine oil, MOGAS, and hydraulic fluid (330 gal/yr), PD 680 (10 gal/yr), and battery acid (12 gal/yr). The neutralization of the battery acid is conducted at the Battery Shop in Building No. 822. PD 680 is a petroleum distillate used as a safety cleaning solvent. PD 680 Type II is currently used in the industrial operations at Twin Cities AFRB; however, both PD 680 Types I and II might have been used in the past. The primary difference between PD 680 Type I and Type II is the flash point of the material. The flash points are 100°F and 140°F for PD 680 Types I and II, respectively.

ii) Corrosion Control Shop

The Corrosion Control Shop is located in Building No. 813. Corrosion control activities include cleaning, sanding, wiping, priming, repainting, and stenciling of aircraft. The paint booth is located in Building No. 813; however, the majority of the corrosion control activities, including aircraft washing, are conducted in Buildings No. 870 and 821. Wastes generated include phenolic paint stripper (200 gal/3 yr), alkali paint stripper (200 gal/3 yr), polyurethane paint thinner (50 gal/yr), acrylic lacquer (20 gal/yr), isopropyl alcohol (10 gal/yr), turpentine (5 gal/yr), nitrate (10 gal/yr), Magnusol 747 (1,250 gal/yr), epoxy paint remover (50 gal/yr), paint sludge (10 gal/yr), waste acids (28 gal/yr) and paint filters (80 lb/yr). The phenolic paint stripper (cold tank stripper) and alkali paint stripper (hot tank stripper) are contained in two 200-gallon strip tanks. Both strip tanks are cleaned approximately once every 3 years. The contents are removed and placed in 55-gallon drums. A sample previously collected from the cold strip tank and analyzed by the USAF OEHL showed the following results: 23 percent phenol, 58 percent methylene chloride, 11 percent water, and the balance surface active agents. No analysis of the hot strip tank was available. Magnusol 747 is the aircraft cleaning compound used during the washing operation. Both Magnusol 747 and 728 have been used in the past. No analysis of the Magnusol 747 was available. However, the material safety data sheet indicated the contents of Magnusol 728 to be 40 percent aromatic hydrocarbons, 5 percent ethylene glycol butyl ether, 3 percent cyclohexanol, and 0.1 percent sodium chromate. The Magnusol cleaning compound is stored in a 2,000-gallon underground tank. The cleaning compound is first diluted six to one before use and then is further diluted during the washing.

operation. The washwater is collected by the floor drains and passes through an oil/water separator before being discharged to the sanitary sewer. The paint sludge is primarily comprised of waste paint thinners, paint removers, and miscellaneous paints, primers, lacquers, and enamels. The types of waste acids include: phosphoric, chromic, sulfuric, hydrochloric, muratic, nitric, and hydrofluoric. Waste acids are neutralized with baking soda (sodium bicarbonate) and then discharged to the sanitary sewer. Paint filters are removed from the spray booth and disposed of approximately four times a year. One set of paint filters contains approximately 36 individual filters. The weight differential between a new set of filters and a used set, ready for replacement, is approximately 20 pounds. An EP toxicity test for metals was conducted on the filters in September, 1982. The results indicated high levels of chromium (52.96 mg/l), which is about 10 times the maximum concentration for the characteristic of EP toxicity. Since early 1982, the paint filters have been wetted down and stored in 55-gallon drums, to be turned over to DPDO.

iii) Fuel Cell Maintenance Shop

The Fuel Cell Maintenance Shop is located in Building No. 870. In addition to repairing and maintaining aircraft fuel cells, this facility is used jointly by the 934th TAG and Minnesota Air National Guard for aircraft washing. Wastes generated include Magnusol 747 and PD 680 (150 gal/yr). The waste quantity of Magnusol 747 is included in the Corrosion Control Shop inventory.

iv) Flightline Maintenance Shop

The Flightline Maintenance Shop is located in Building No. 821. Flightline maintenance activities, which

include engine run-up, refueling, servicing, and washing are performed. Wastes generated include Magnusol 747, PD 680 (50 gal/yr), and ethylene glycol (750 gal/winter). The waste quantity of Magnusol 747 is included in the Corrosion Control Shop inventory. The ethylene glycol is diluted one to one and used for aircraft de-icing, which is conducted outside on the parking apron. The diluted ethylene glycol is washed off the apron into a storm sewer or onto the local ground surface.

V) Inspection Section

The Inspection Section is located in Building No. 821. Activities performed include inspection, unscheduled maintenance, draining engine oil, and some aircraft washing. Wastes generated include engine oil (200 gal/yr) and Magnusol 747. The waste quantity of Magnusol 747 is included in the Corrosion Control Shop inventory.

vi) NDI Lab

The NDI Lab is located in Building No. 822. Non-destructive testing methods, including x-ray, magnaflux, and ultrasound are performed to determine material defects of aircraft structures, components parts, and related ground equipment. Wastes generated include biodegradable penetrant (55 gal/3 yr), developer (60 gal/yr), glacial acetic acid (40 gal/yr), fixer (60 gal/yr), and PD 680 (30 gal/3 yr). All the developing solutions are contained in dip tanks. The penetrant and PD 680 dip tanks are cleaned out approximately once every 3 years. The developer and fixer dip tanks are cleaned annually. The fixer is collected in a 55-gallon drum and transported to the base photo lab to be processed for silver recovery.

vii) Battery Shop

The Battery Shop is located in Building No. 822. The only waste generated during the servicing of lead batteries is battery acid (sulfuric acid, 12 gal/yr), which is neutralized with baking soda (sodium bicarbonate) in a neutralization tank. The pH is checked, and then the contents of the neutralization tank are discharged to the sanitary sewer. The AGE Maintenance Shop and the Motor Vehicle Maintenance Shop also use this facility for the neutralization of waste battery acid.

viii) Pneudraulics Shop

The Pneudraulics Shop is located in Building No. 822. This shop services and repairs all aircraft pneumatic and hydraulic equipment. Wastes generated include hydraulic fluid (50 gal/yr) and PD 680 (80 gal/yr). There are two 20-gallon dip tanks containing PD 680 at this shop. The dip tanks are cleaned approximately two to three times per year.

ix) Propeller Shop

The Propeller Shop is located in Building No. 822. The only waste generated during the maintenance of aircraft propellers is hydraulic fluid (150 gal/yr), which is routinely drained and changed in the propellers.

x) Repair and Reclamation Shop

The Repair and Reclamation Shop is located in Building No. 822. The only waste generated during the fabrication and repair of sheet metal is PD 680 (100 gal/yr). The

PD 680 dip tank located in the shop is cleaned approximately two to three times per year.

xi) Motor Vehicle Maintenance Shop

The Motor Vehicle Maintenance Shop is located in Building No. 803. Wastes generated during the repair and maintenance of motor vehicles include hydraulic fluid (10 gal/yr), engine oil (600 gal/yr), PD 680 (60 gal/yr), battery acid (120 gal/yr), and ethylene glycol (250 gal/yr). The PD 680 dip tank is cleaned twice a year. The battery acid is neutralized at the Battery Shop in Building No. 822.

b. Minnesota Air National Guard

i) Flightline Maintenance Shop

The Flightline Maintenance Shop is located in Building No. 680. Activities include engine run-up, refueling, and servicing. Wastes generated include commingled hydraulic fluid and synthetic engine oil (250 gal/yr).

ii) Corrosion Control Shop

The Corrosion Control Shop is located in Building No. 687. Activities include cleaning, sanding, wiping, priming, repainting, and stenciling of aircraft and ground support equipment. Wastes generated include commingled MEK and toluene (100 gal/yr), and paint filters and sludge (20 gal/yr). No analysis of the paint filters from the spray booth was available. However, since operations are similar to the 934th TAG Corrosion Control Shop, it is assumed that the paint filters contain constituents similar to those previously identified. The paint sludge consists primarily of waste paint thinners, paint removers,

and miscellaneous paints. All aircraft washing is conducted at the washrack in Building No. 870 in Area N.

iii) Phase Inspection Dock

The Phase Inspection Dock is located in Building No. 685. Activities performed include inspection, unscheduled maintenance, and engine oil draining. Wastes generated include commingled hydraulic fluid and engine drain oil (200 gal/yr), and contaminanted JP-4.

iv) Environmental Systems Shop

The Environmental Systems Shop is located in Building No. 687. Activities performed include the organizational and intermediate maintenance of aircraft oxygen and pneumatic systems, and maintenance of aircraft fire extinguishers. The only waste generated is bromochloromethane (10 gal/yr).

v) Pneudraulics Shop

The Pneudraulics Shop is located in Building No. 687. This shop services and repairs all aircraft pneumatic and hydraulic equipment. Wastes generated include PD 680 (60 gal/yr) and hydraulic fluid (50 gal/yr).

vi) Propulsion Shop

The Propulsion Shop is located in Building No. 687. Wastes generated during the maintenance of the aircraft propulsion system include commingled synthetic engine oil, hydraulic fluid, and PD 680 (600 gal/yr).

vii) NDI Shop

The NDI Shop is located in Building No. 687. Non-destructive testing methods, including x-ray, magnaflux, and ultrasound are performed to determine material defects of aircraft structures and component parts. The NDI Shop also assists the Corrosion Control Shop with aircraft cleaning and paint stripping. Wastes generated include MEK (12 gal/yr), and paint stripper (6 gal/yr).

viii) Surface Transportation/Motor Pool

The Motor Pool is located in Building No. 662. Prior to 1977, the Motor Pool was located in Building No. 614. Wastes generated during the repair and maintenance of motor vehicles include 500 gal/yr of commingled engine drain oil, PD 680, paint thinner, and trichloroethane. All wastes are placed in a 250-gallon underground tank located outside the building. A contractor pumps the tank out approximately twice a year.

ix) Battery Shop

The Battery Shop is located in Building No. 662. The only waste generated during the servicing of lead batteries is battery acid (sulfuric acid, 25 gal/yr). The battery acid is neutralized with baking soda (sodium bicarbonate) in a neutralization tank and then discharged to the sanitary sewer. Prior to 1977, the battery acid was neutralized with baking soda and discharged to a leaching pit filled with crushed limestone. The leaching pit was located outside of Building No. 614.

c. Navy Air Reserve

i) Ordnance Shop

The Ordnance Shop is located in Building No. 1 (P-1 Hanger). In approximately 1979, a project was initiated in which the corrosion preventative "gunk" is removed from the parts of guns. PD 680 is used for removing the preservative. The 100-gallon PD 680 dip tank is cleaned out approximately twice a month. The only waste generated is PD 680 (2,400 gal/yr), which is collected in 55-gallon drums and removed by a contractor.

ii) Ground Support Shop

The Ground Support Shop is located in Building No. 1 (P-1 Hanger). The only waste generated during the intermediate maintenance of ground support equipment is paint sludge (50 gal/2 yr).

3. Fuels

The major fuel storage area on Twin Cities AFRB is the POL tank farm located in Area D. This facility is used jointly by the 934th TAG and the Minnesota Air National Guard. The POL tank farm houses two aboveground, diked tanks used for JP-4 storage. The capacities of the storage tanks are 6,000 barrels and 5,000 barrels (Facilities No. 600 and 601, respectively). Due to the upgrading and construction of safeguards at the POL tank farm, all JP-4 fuel is temporarily being stored at Facility No. 2750. Facility No. 2750 consists of one underground, 5,000-barrel storage tank located in Area N. The construction program to upgrade the POL tank farm began in the fall of 1981 and is expected to be completed by May, 1983. The upgrading of the

POL tank farm includes the heightening of the dike walls and the installation of an oil/water separator. There are numerous other tanks on-base for the storage of heating fuel oil, MOGAS, and de-icing liquids. A complete inventory of the major existing POL storage tanks, including facility number, type of POL stored, capacity, and the type of tank, is included in Appendix F.

Several fuel spills have occurred on Twin Cities AFRB in the past. A spill occurred at the POL tank farm in February, 1977 when an estimated 143,000 gallons of JP-4 was accidentally discharged into the diked area. No fuel overtopped the diked wall. The 1977 Fuel Spill Site (Site No. 3) will be discussed in further detail in Section IV-B, "Disposal Sites Identification and Evaluation", Page IV - 26. Other spills reported during the interview process, which will also be discussed in Section IV-B, include the following: a MOGAS Spill near Building No. 614 (Site No. 4); a Suspected POL Spill Area near the liquid oxygen storage pad in Area D (Site No. 5); and a Past Fuel Spill Area at the old aqua-injection AVGAS system in Area N (Site No. 7).

The major POL storage tanks are cleaned every 3 to 5 years by a contractor. The quantities of sludge generated per tank during a cleaning operation are small, and the sludge consists mainly of water, rust, dirt, and fuel. Since 1972, the sludge generated during the tank cleaning operations has been removed by the contractor. There were two reported incidents of on-base sludge disposal. Approximately 100 to 200 gallons of unweathered leaded AVGAS sludge was disposed of at the Small Arms Range Landfill (Site No. 1) in approximately 1969. The sludge was placed in a pit in the northwest corner of the landfill and weathered before burial. In about

1971 to 1972, approximately 150 gallons of unweathered leaded AVGAS sludge was buried at the Liquid Sludge Burial Pit (Site No. 6). Prior to 1969, the final disposition of the sludge is unknown and this information was not available in the files or during the interviews.

4. Fire Department Training Exercises

Fire department training activities have been common since activation of the base. Training exercises are conducted jointly by the 934th TAG, the Minnesota Air National Guard, and the Metropolitan Airports Commission fire department personnel. All fire department training exercises are conducted at the Metropolitan Airports Commission Fire Department Training Area located on property, off the Twin Cities AFRB.

5. Polychlorinated Biphenyls (PCB)

Polychlorinated biphenyls (PCB) are among the most chemically and thermally stable organic compounds known to man. Because of their stability, PCB, once introduced into the environment, persist for long periods of time and are not readily biodegradable. The current established PCBs criteria are as follows:

PCB Concentration (ppm)	Classification	Disposal Requirements
Less than 50	Non-regulated	Sanitary Landfill
Between 50 and 500	PCB-contaminated	Permitted Hazardous Waste Landfill or incineration
Greater than 500	PCB	Incineration

Possible sources of PCB at Twin Cities AFRB are electrical transformers and capacitors. All in-service transformers were serviced and checked in 1975. There are five transformers containing PCB-contaminated transformer oil still in service. Three of the transformers are located at Building No. 821 and two are located at Building No. 855.

There are nine out-of-service transformers at Twin Cities AFRB, all of which have been tested. Three are stored at the Hazardous Storage Area. Two of these transformers are PCB-contaminated (311 and 280 ppm) and no PCB were detected in the third. Originally these transformers were stored outside and adjacent to Building No. 735. A small spill was suspected underneath one of the transformers. Soil samples were taken by USAF personnel and no PCB were detected. These three transformers are now stored inside Building No. 735 inside 55-gallon drums. The remaining six transformers are stored in an open area across the street from Building No. 752. Two of these transformers contain 18 ppm of PCB, and no PCB were detected in the other four. It was reported that these six transformers are used by the electricians for training other electrical personnel.

Other than the suspected small spill at the Hazardous Storage Area (Site No. 8), there is no record of any major PCB spills from leaking or blown transformers.

6. Pesticides

Pesticides are commonly used at Twin Cities AFRB. The Entomology Shop and Roads and Grounds control the use and handling of all pesticides used to control cockroaches, ants, and mice, as well as undesirable weeds and overgrowth.

The major pesticides currently used by the 934th TAG and the estimated usage (if known) are Dia-A-Cide (25 gal/mo), Ficam-W (2 lb/mo), Baygon, Malathion, Talgon-G, and Diazinon-4E. The major herbicides currently used are Trimec and Permatrol.

The major pesticides currently used by the Minnesota Air National Guard are Warfarin (1 lb/yr), Pyrethrins, and Rozol mouse bait. The major herbicides currently used are Weedar-64 (25 gal/yr), HYVAR-X (15 gals/yr), and Habco Bromex (50 lb/yr).

There were no reports of banned or restricted pesticides or herbicides currently used on-base.

7. Wastewater Treatment

The Twin Cities AFRB sanitary sewer system is connected to the City of Minneapolis municipal system. All sanitary and industrial wastewater is treated at the City of Minneapolis municipal treatment plant. The flow from sanitary sources is estimated to be 34,000 gallons per day (gpd) and the flow from industrial sources is estimated to be 40,000 gpd. No analyses of the raw sanitary or industrial wastewater leaving the base were available.

There are four oil/water separators located at various industrial shops to provide pretreatment of the industrial wastewater. The four oil/water separators are located at Buildings No. 803, 821, and 870, and at the POL tank farm. The effluent from the oil/water separators is discharged to the sanitary sewer, with the exception of the oil/water separator at the POL tank farm. The oil/water separator at the POL tank farm has been installed, but will not be in operation until May, 1983. Prior to construction of the oil/water separator in Building No. 821 (built in 1977), the floor drains discharged to the storm sewer. The effluent from the oil/water separator at the POL tank farm, which treats surface runoff from the diked areas, will be discharged to a storm drainage ditch which then discharges to the Mississippi River. The slop oil removed by the oil/water separators is periodically pumped out and disposed of as waste POL.

8. Available Water Quality Data

All potable water for Twin Cities AFRB is obtained from the City of Minneapolis. The potable water is supplied to the base by one 12-inch main and one 6-inch main. Annual consumption is approximately 19.5 million gallons.

The storm drainage system at Twin Cities AFRB is composed of man-made ditches and storm sewers. There are no surface-water bodies or natural watercourses on-base. Stormwater exits the base from several points. It exits to the north from Area B, by the main gate, into the Minneapolis storm sewer system; and from Area D, flowing into the Mississippi River. The effluent from the oil/water separator at the POL tank farm will also discharge to the storm drainage ditch which flows into the Mississippi River. This discharge is authorized under the National Pollutant Discharge

Elimination System (NPDES) Permit No. MN 0052141. Stormwater also exists to the south from Areas C, D, and N into the Metropolitan Airports Commission storm sewer system. Metropolitan Airports Commission monitors the combined stormwater prior to discharge to the Minnesota River. The Metropolitan Airports Commission discharge is authorized under NPDES Permit No. MN 0002101.

9. Other Activities

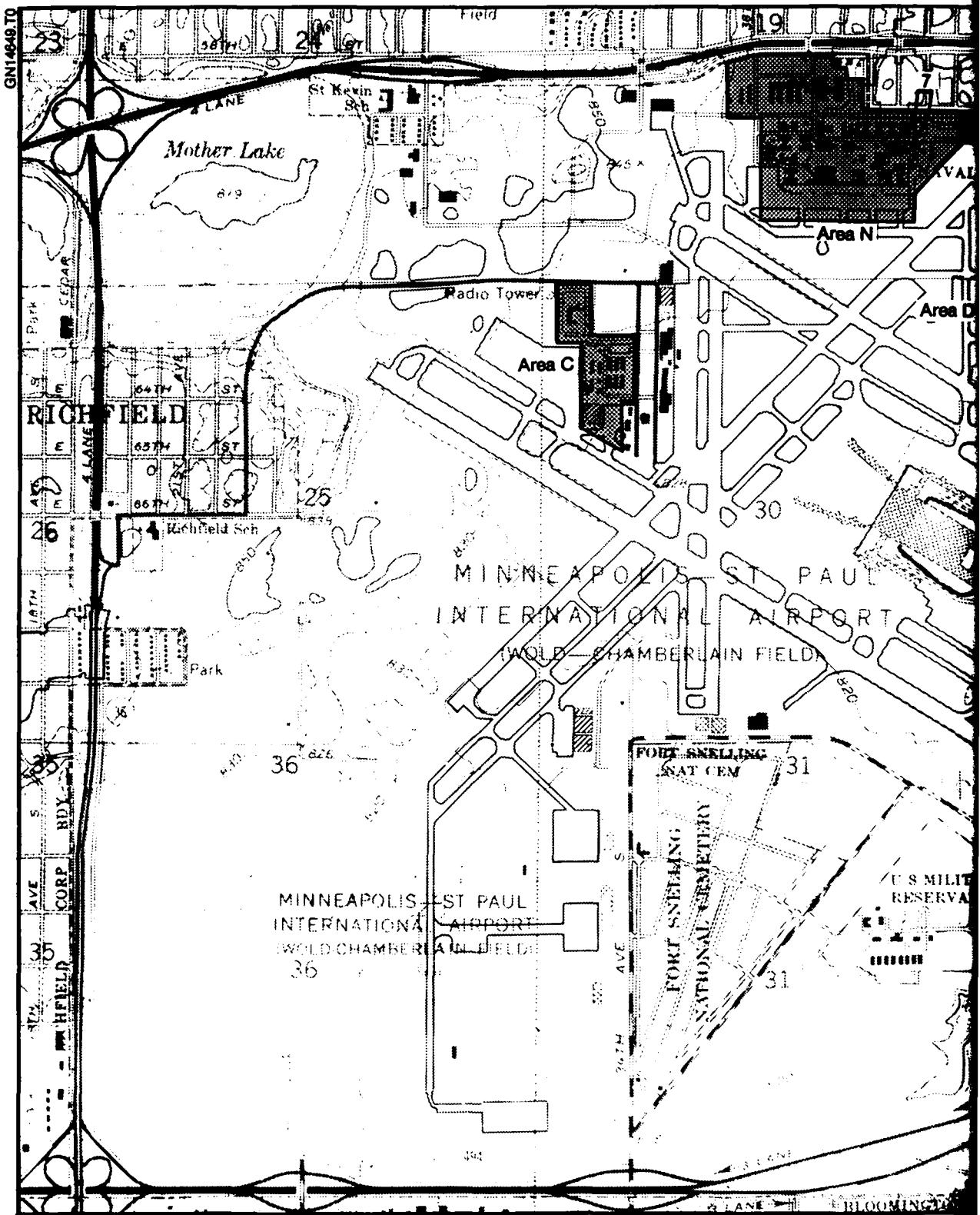
The review of the records and information obtained during the interviews produced no evidence of the past or present storage, disposal, or handling of biological or chemical warfare agents at Twin Cities AFRB. No explosive ordnance activities have been conducted at Twin Cities AFRB.

The records search indicated that trichloroethylene (TCE) has been used in the past at Twin Cities AFRB. Some industrial activities used small quantities of TCE as a cleaning solvent until 1980. However, there were no indications of any large-scale use of TCE or any problems associated with the handling or disposal of TCE at Twin Cities AFRB.

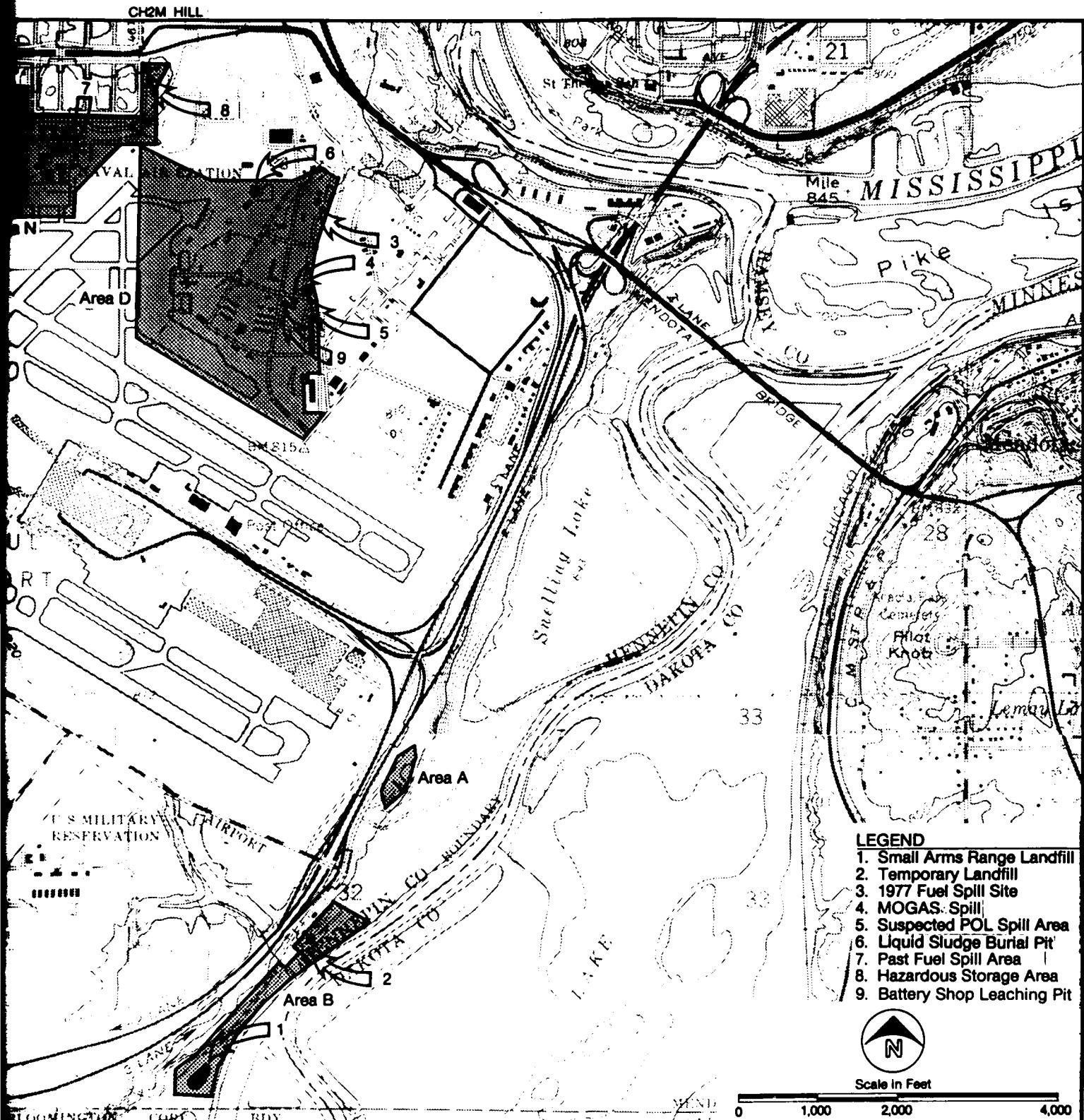
All asbestos materials have been handled in accordance with the Occupational Safety and Health Administration (OSHA) requirements during building modification and rehabilitation. Asbestos building materials are removed by a contractor for proper disposal.

B. DISPOSAL SITES IDENTIFICATION AND EVALUATION

Interviews with 40 past and present base personnel (Appendix C) resulted in the identification of nine disposal and spill sites at Twin Cities AFRB. The approximate locations of these sites are shown on Figure 10.



Location map of identified diatom species



Identified disposal and spill sites at Twin Cities AFRB.

FIGURE 10.

A preliminary screening was performed on all eight identified past disposal and spill sites based on the information obtained from the interviews and available records from the base and outside agencies. Using the decision tree process described in the Methodology Section, page I-5, based on all of the above information, a determination was made as to whether a potential exists for hazardous material contamination in any of the identified sites. For those sites where the potential for hazardous material contamination was identified, a determination was made as to whether a potential exists for contaminant migration from these sites. The sites where the potential for migration exists were then rated using the U.S. Air Force Hazard Assessment Rating Methodology (HARM), which was developed jointly by the Air Force, CH2M HILL, and Engineering-Science for specific application to the Air Force Installation Restoration Program. The HARM system considers four aspects of the hazard posed by a specific site: the waste and its characteristics, the potential pathways for waste contaminant migration, the receptors of the contamination, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating. A more detailed description of the HARM system is included in Appendix G. Copies of the completed rating forms are included in Appendix H. A summary of the overall hazard ratings is given in Table 5.

The following is a description of each site, including a brief discussion of the rating results.

- Site No. 1, Small Arms Range Landfill (overall score 60), was the main base landfill for the entire base from approximately 1963 to 1972. Prior to 1963, the base refuse was transported to

Table 5
SUMMARY OF RESULTS OF SITE RATINGS

Site No.	Site Description	Subscore (% of Maximum Score in Each Category)			Management Practices Factor	Overall Score	Page Reference of Site Rating Form
		Receptors	Pathways	Characteristics			
1	Small Arms Range Landfill	68	51	60	1.0	60	H-1
4	MOGAS Spill	77	48	32	1.0	52	H-3
5	Suspected POL Spill Area	77	48	40	1.0	55	H-5
6	Liquid Sludge Burial Pit	77	41	40	1.0	53	H-7
7	Past Fuel Spill Area	79	48	40	1.0	56	H-9
8	Hazardous Storage Area	79	48	40	1.0	56	H-11

INV

a nearby landfill located off the installation. After 1972, the base refuse was removed by a contractor and disposed of off the installation. The Small Arms Range Landfill is located in Area B along the Minnesota River and covers approximately two to three acres. Between 1963 and 1969, the base refuse was burned in a pit located near the western edge of the landfill. The burned refuse was then buried and covered with fill. The burning of the base refuse was halted in approximately 1969, and between 1969 and 1972 the refuse was buried and covered on a daily basis. In addition to the general base refuse disposed of at the site, paint sludge (primarily paint thinners, paint removers, and miscellaneous waste paints) and paint filters were also disposed of at this site. An EP toxicity test for metals was conducted on the paint filters, and results showed chromium levels (52.96 mg/l) about 10 times the maximum concentration for the characteristic of EP toxicity. Other metals detected include cadmium, lead, and zinc. In addition, approximately 100 to 200 gallons of leaded AVGAS sludge was buried at this site. The sludge was placed in a pit in the northwest corner of the landfill and weathered before burial. Other than those items mentioned above, the interviewees reported that no industrial wastes from the flightline were buried at this site. The overall rating score for this site is 60. The receptors subscore (68) is due mainly to the presence of a major wetlands within a 1-mile radius of the site, the distance to the reservation boundary (less than 100 feet), and the water quality designation of the Minnesota River. The pathways subscore (51) is due mainly

to the depth to the ground water (less than 10 feet). The waste characteristics subscore (60) is due to the known small quantities of leaded sludge, paint sludge, and paint filters which have been disposed of at this site.

- o Site No. 2, Temporary Landfill (not rated), was a temporary landfill used for approximately one month in 1965. Like Site No. 1, this landfill is located in Area B along the Minnesota River, but at a higher elevation near the top of the river bluff. This landfill was used in 1965 when the Minnesota River flooded the Small Arms Range Landfill. It was reported by interviewees that no industrial wastes were disposed of at this site. Only general base refuse was buried at this landfill for a short period of time. Since there is no indication that hazardous wastes are present, there appears to be no potential for contamination and the site was not rated.
- o Site No. 3, 1977 Fuel Spill Site (not rated), was the site of a JP-4 spill which occurred on February 12, 1977, at the POL tank farm. Approximately 143,000 gallons of JP-4 was accidentally discharged from the 5,000-barrel storage tank (Facility No. 601). The JP-4 was spilled into the diked area surrounding the tank and no fuel was observed to have overtopped the dike wall. No seepage through the asphalt-lined, soil-filled dike was observed. Emergency response measures were undertaken by base and Metropolitan Airports Commission personnel. The fuel was pumped out of the diked area and recovery was estimated to be 100 percent. On February 17, 1977, soil borings were collected on the dike and

a slight fuel odor was qualitatively determined from the samples. No further action was taken at that time. During a construction program to upgrade the POL storage area in November 1981, a pit was excavated for the installation of an oil/water separator. A hydrocarbon layer was observed to be floating on standing water inside the pit at a depth of approximately 12 feet bbls. A subsurface survey, which included 13 shallow exploratory borings and one downgradient monitoring well, was conducted at this site during 1982. The subsurface survey confirmed the presence of JP-4 contamination in the upper soil zone and determined that the JP-4 contamination is migrating in a northeasterly direction at a rate of about 22 feet per year. The problem confirmation and quantification investigation has been completed at this site. Since remedial actions are planned for this site in March, 1983, the site was not rated.

- Site 4, MOGAS Spill (overall score 52), was the site of a 600-gallon MOGAS spill in approximately 1958 to 1959. The spill occurred on the pavement near the old Motor Pool (Building No. 614). The MOGAS was accidentally discharged when a valve broke on a fuel truck. It was reported that some of the fuel reached a nearby storm drainage ditch. The overall score for this site is 52. The receptors subscore (77) is due mainly to the distance to the nearest well (2,500 feet), and the presence of a major wetlands within a 1-mile radius of the site. The pathways subscore (48) is

due mainly to the distance to a nearby storm drainage ditch (less than 100 feet). The waste characteristics subscore (32) is due to the suspected small quantities of MOGAS which reached the local ground surface and the storm drainage ditch.

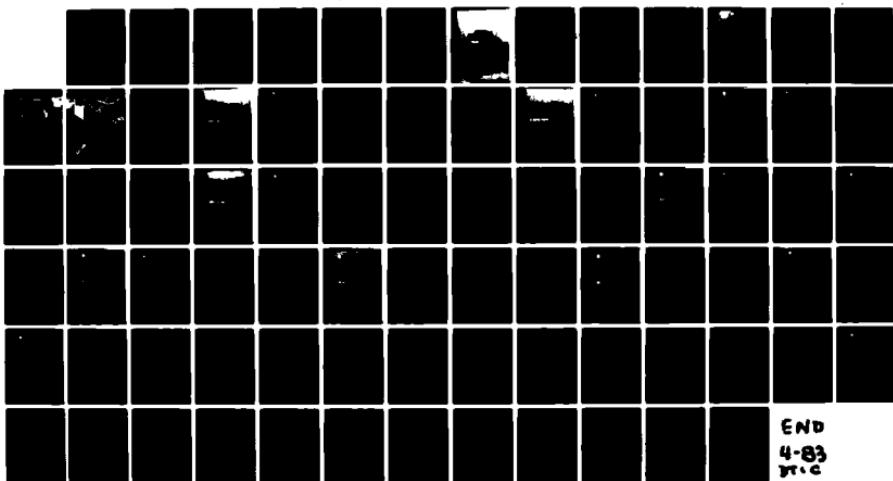
- Site No. 5, Suspected POL Spill Area (overall score 55), was the site of an aboveground, 7,500-gallon capacity railroad tank car used for the storage of heating fuel oil. The railroad tank car has been removed from the site. The site is located near the liquid oxygen storage facility. During excavation necessary to remove the tank car, the soil was observed to be slightly contaminated with a POL product. There were no reports of any major heating fuel oil spills at this site. Another potential source of the POL could be from a spill on the railroad track which once ran through the site. The railroad, which extended to the POL tank farm, was used for the delivery of fuel to the POL tank farm. The overall score for this site is 55. The receptors subscore (77) is due mainly to the distance to the nearest well (2,700 feet), and the presence of a major wetlands within a 1-mile radius of the site. The pathways subscore (48) is due mainly to the distance to a nearby storm drainage ditch (less than 50 feet). The waste characteristics subscore (40) is due to the small quantities of POL observed in the soil at this site.
- Site No. 6, Liquid Sludge Burial Pit (overall score 53), was used once for the disposal of unweathered sludge. In approximately 1971, 150 gallons of unweathered sludge was placed in the

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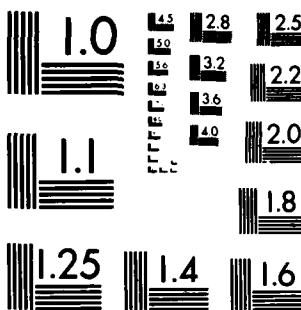
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pit and buried. The sludge is believed to have been leaded AVGAS sludge, generated during the cleaning of the POL storage tanks. The sludge consists mainly of water, rust, dirt, and fuel. The pit is located to the north of Building No. 659. The overall score for this site is 53. The receptors subscore (77) is due mainly to the distance to the nearest well (2,800 feet), and the presence of a major wetlands within a 1-mile radius of the site. The pathways subscore (41) is due mainly to the distance to the nearest storm drainage ditch (1,100 feet). The waste characteristics subscore (40) is due the suspected small quantities of unweathered leaded AVGAS sludge buried at this site.

- o Site No. 7, Past Fuel Spill Area, (overall score 56), is the site of five underground POL storage tanks which are currently used for the storage of heating fuel oil. Four of the tanks were used to store AVGAS in the past and were part of the Aqua-injection AVGAS system. Interviewees reported that numerous (about two dozen) small spills have occurred at this site due to overtopping of the tanks. One larger spill occurred during the winter of 1966, when approximately 250 to 500 gallons (exact quantity unknown) of AVGAS was spilled onto the local ground surface during a refueling operation. The aqua-injection AVGAS system was later converted to heating fuel oil storage. The overall score for this site is 56. The receptors subscore (79) is due mainly to the distance to the nearest well (150 feet), and the presence of a major wetlands within a 1-mile radius of the site. The pathways subscore (48) is

due mainly to the distance to the nearest storm sewer (100 feet). The waste characteristics subscore (40) is due to suspected medium quantities of AVGAS which have spilled in this area.

- o Site No. 8, Hazardous Storage Area (overall score 56), is presently used for the storage of stock industrial solvents and cleaners, empty 55-gallon drums, and the temporary storage of hazardous wastes awaiting proper disposal. The buildings on this site are also used for the storage of non-hazardous items, such as office furniture. All materials are stored within a fenced-in area to restrict access. Three transformers were originally stored outside and adjacent to Building No. 735 located in the Hazardous Storage Area. Two of these transformers contain PCB-contaminated transformer oil (311 and 280 ppm). A small spill was suspected underneath one of the transformers. Soil samples were taken from this area, and no PCB were detected in the analyses. These transformers are presently stored inside Building No. 735 in 55-gallon drums, awaiting proper disposal. Another area of concern was the storage of a reported 37 drums of suspected hazardous wastes. It was reported that 28 of the drums contained a mixture of engine oils and hydraulic fluids. The remaining 9 drums contained a mixture of miscellaneous paint strippers and solvents. These drums had been stored outside in the Hazardous Storage Area during 1981 and part of 1982. None of the drums were observed to be leaking; however, some of the drums were in poor condition, and several were overfilled resulting in bulging.

Some residuals were probably present on the tops of the containers. During the latter part of the 1981-1982 winter, a pool of water around the drums, which was the result of snowmelt, was observed to have an oil sheen on the surface. A sample was previously collected by USAF personnel from the pool of water and analyzed. Analysis indicated that the sample was composed of 83 percent water and 17 percent organic layer floating on top. Analysis of the organic layer showed it to be an aliphatic hydrocarbon type oil, similar to engine oil. Analysis of the water indicated a lead concentration of .092 mg/l. Analyses for volatile organics were not conducted. A potential source of the lead was the paint on the drums, which could have been removed by some paint stripper residuals. Since the ground was frozen during that time of the year, the contaminated pool of water would have been further diluted with snowmelt during runoff. The runoff from this area drains north off the installation toward a storm water drainage ditch along Crosstown Highway. The potential exists that some very small quantities of engine oil may have infiltrated into the ground prior to the ground becoming frozen during the winter. In April, 1982, DPDO accepted accountability of the waste materials and the 37 drums were removed for proper disposal. At the time of the base visit, only one drum, which was returned due to the improper identification of the contents, remained at the Hazardous Storage Area. The overall score for this site is 56. The receptors subscore (79) is due mainly to the distance to the nearest well (1,700 feet), and the presence of a

major wetlands within a 1-mile radius of the site. The pathways subscore (48) is due mainly to the distance to a nearby drainage ditch. The waste characteristics subscore (40) is due to the small quantities of engine oil which may have infiltrated into the ground at this site.

- o Site No. 9, Battery Shop Leaching Pit (not rated), was in use prior to 1977 and was located outside of the old Motor Pool (Building No. 614). Waste battery acid (sulfuric acid) generated during the servicing of lead batteries was neutralized with baking soda (sodium bicarbonate) and then discharged to the leaching pit. Approximately 25 gal/yr of neutralized battery acid were discharged to the leaching pit. The leaching pit was filled with crushed limestone for further neutralization. There is a potential that the waste battery acid may have contained some lead from the lead batteries. Since hazardous wastes are not present in sufficient quantity, the site was not rated.

A total of 9 disposal and spill sites were identified at Twin Cities AFRB. Of these, a total of 6 were rated using the HARM rating system. These sites were identified as having a potential for hazardous material contamination and migration. A complete listing of all the sites, including potential hazards, is given in Table 6.

Table 6
DISPOSAL SITE RATING SUMMARY

<u>Site No.</u>	<u>Site Description</u>	<u>Potential Contamination</u>	<u>Hazard Migration</u>	<u>Rated</u>
1	Small Arms Range Landfill	Yes	Yes	Yes
2	Temporary Landfill	No	NA ^a	No
3	1977 Fuel Spill Site	Yes	Yes	No ^b
4	MOGAS Spill	Yes	Yes	Yes
5	Suspected POL Spill Area	Yes	Yes	Yes
6	Liquid Sludge Burial Pit	Yes	Yes	Yes
7	Past Fuel Spill Area	Yes	Yes	Yes
8	Hazardous Storage Area	Yes	Yes	Yes
9	Battery Shop Leaching Pit	No	NA ^a	No

^aNA = Not applicable using decision tree methodology.

^bRemedial actions will be conducted at Site No. 3 in March, 1983.

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V. CONCLUSIONS

- A. Information obtained through interviews with 40 past and present base personnel, base records, shop folders, and field observations indicates that small quantities of hazardous wastes have been disposed of on Twin Cities AFRB property in the past.
- B. No evidence of environmental stress resulting from past disposal of hazardous wastes was observed at Twin Cities AFRB.
- C. The potential for migration of hazardous contaminants in Areas A, C, D, and N is low because of (1) low ground-water table, and (2) the presence of low-permeability confining strata in the unsaturated zone above the uppermost aquifer. Although low, the potential for contaminant migration exists because of the moderate permeability of the soil beneath the low-permeability confining strata.
- D. The potential for migration of hazardous contaminants in Area B (Small Arms Range) is high because of (1) high ground-water table, (2) moderate soil permeability, (3) proximity to the Minnesota River and location within the 100-year flood plain, and (4) absence of the low-permeability confining strata (Platteville Limestone and Glenwood Shale) in the unsaturated zone above the water table.
- E. Table 7 presents a priority listing of the rated sites and their overall scores. The following site was designated as the area showing the most significant potential

Table 7
PRIORITY LISTING OF DISPOSAL SITES

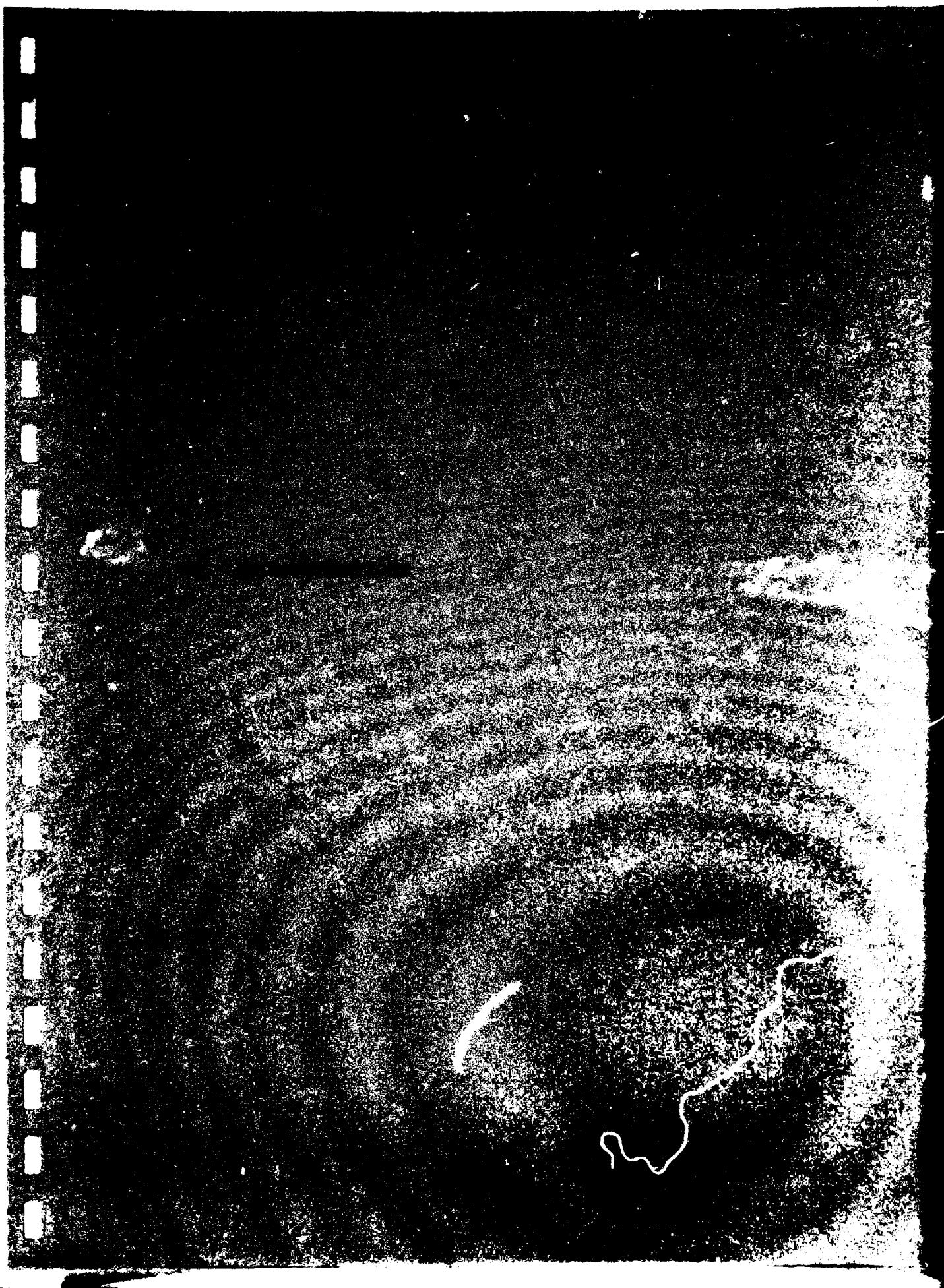
<u>Site No.</u>	<u>Site Description</u>	<u>Overall Score</u>
1	Small Arms Range Landfill	60
7	Past Fuel Spill Area	56
8	Hazardous Storage Area	56
5	Suspected POL Spill Area	55
6	Liquid Sludge Burial Pit	53
4	MOGAS Spill	52

(relative to other Twin Cities AFRB sites) for environmental impact.

1. Site No. 1 (Small Arms Range Landfill)

This site was used as the main base landfill from approximately 1963 to 1972. In addition to the general base refuse, small quantities of hazardous wastes were reportedly disposed of at this site. The potential hazardous wastes include paint sludge (primarily paint thinners and miscellaneous paint residues), paint filters (containing chromium), and leaded AVGAS sludge.

F. The remaining sites (Sites No. 4, 5, 6, 7, and 8), for reasons previously stated, are not considered to present significant environmental concerns. Therefore, no Phase II work is recommended.



VI. RECOMMENDATIONS

A. PHASE II PROGRAM

A limited Phase II monitoring program is recommended to confirm or rule out the presence and/or migration of hazardous contaminants. The priority for monitoring at Twin Cities AFRB is considered low to moderate, since no imminent hazard has been determined.

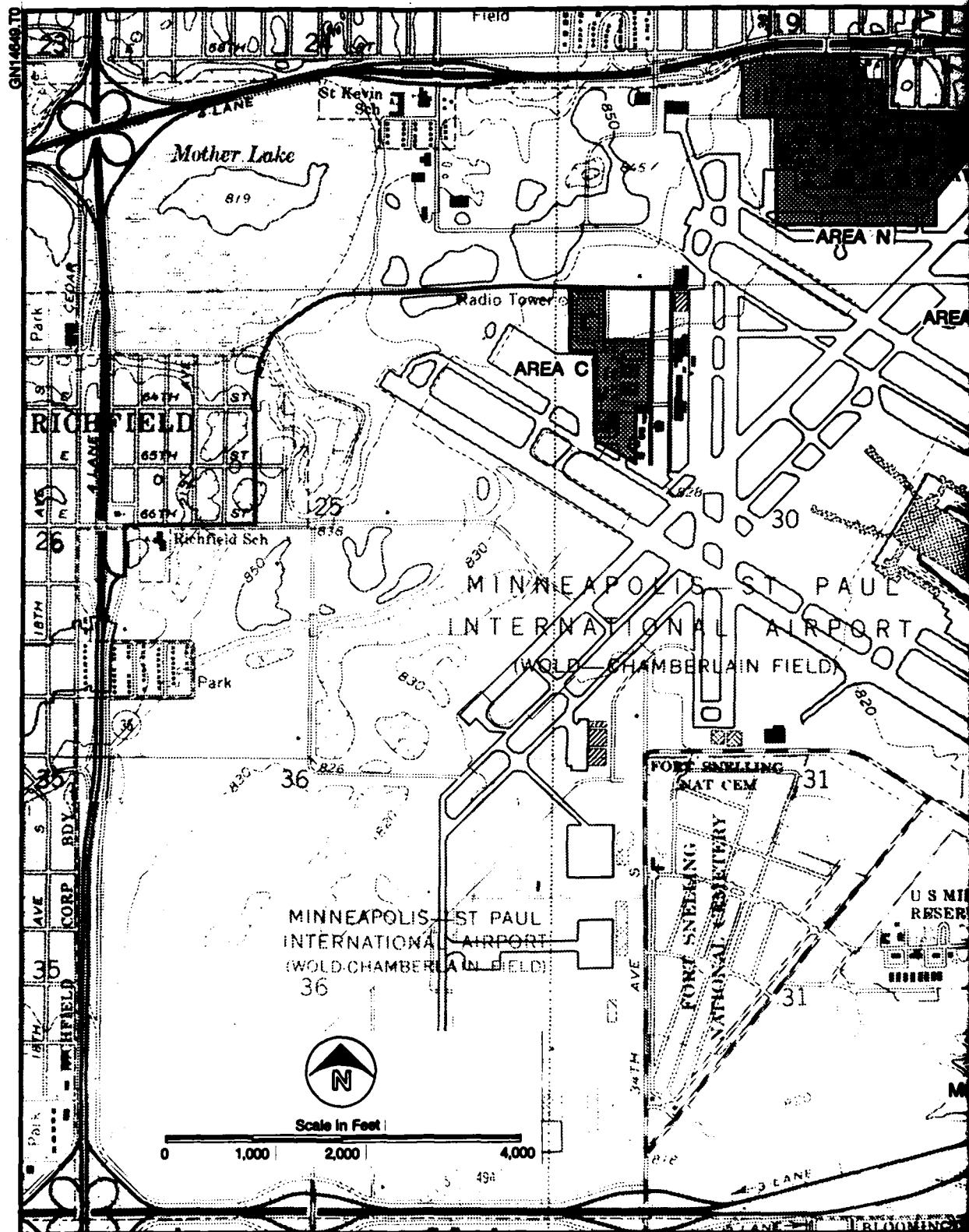
Table 8 presents a summary of the recommended analyses and the rationale for the analyses. Specifically, monitoring is recommended for the Small Arms Range Landfill (Site No. 1). The approximate monitoring well locations are shown on Figure 11.

1. Small Arms Range Landfill (Site No. 1)

It is recommended that one upgradient and two downgradient wells be installed. All three wells should be drilled to a depth 30 feet below the water table (approximately 40 feet bsl) and screened from one foot above the water table to 30 feet below the water table. Water samples collected from the wells should be analyzed for volatile organic compounds, phenols, pH, conductivity, COD, TOC, oil and grease, pesticides, and suspect heavy metals (cadmium, chromium, lead, and zinc). It is not the intent of the monitoring wells to determine the vertical and/or horizontal extent of contamination (if any), but to confirm or rule out the presence and/or migration of the suspected contaminants.

Table 8
RECOMMENDED ANALYSES AND RATIONALE
FOR THE RECOMMENDED ANALYSES

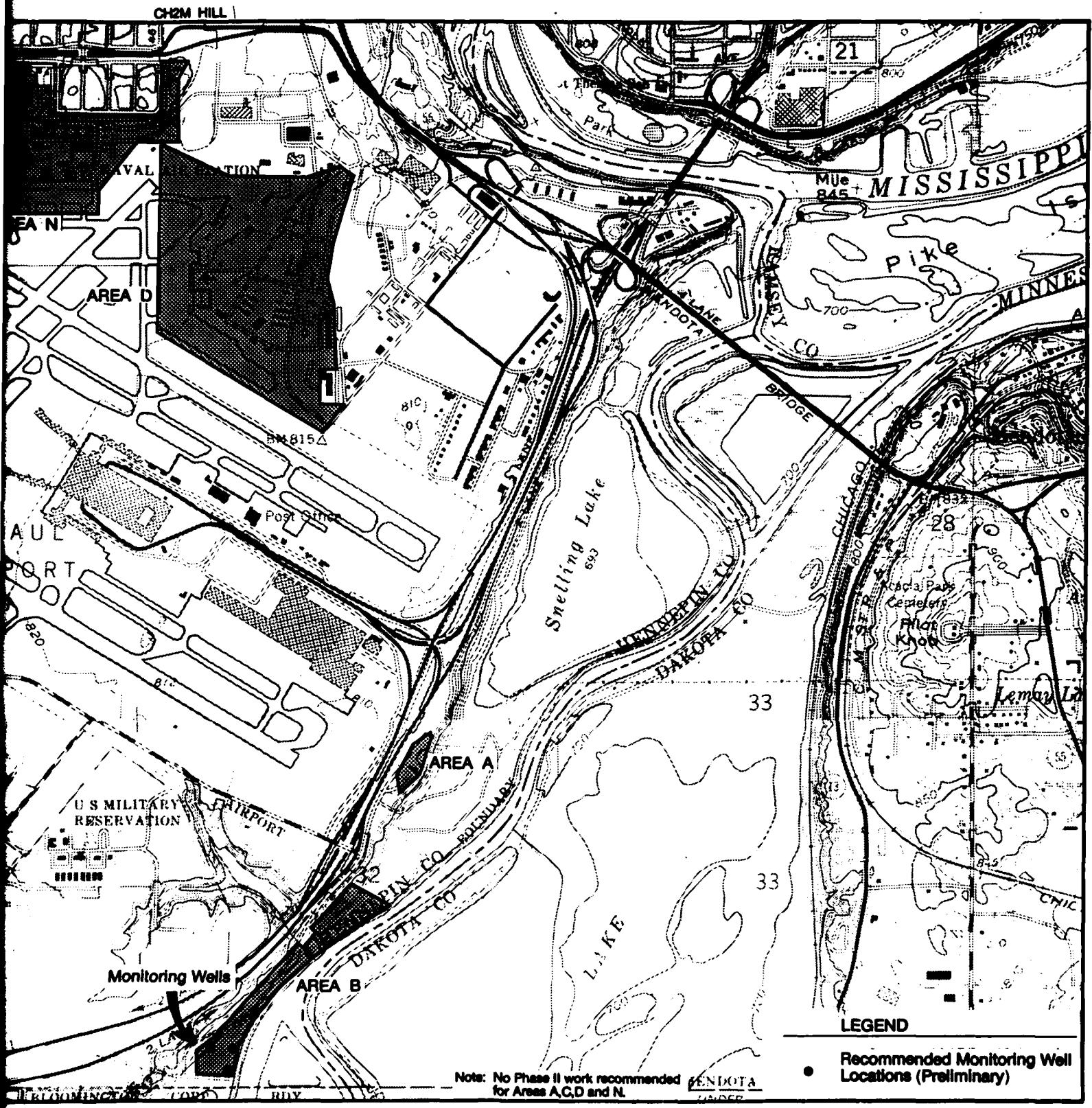
Parameters	Rationale
Volatile Organic Compounds	Organic solvents and paint stripper used on-base in the past
Phenols	Phenolic cleaner and paint stripper used on-base in the past
Heavy Metals (Cadmium, Chromium, Lead, and Zinc)	Potential sources identified (paint, paint filters, and leaded fuel)
COD, TOC, Oil and Grease, pH, and Conductivity	Indicators of nonspecific contamination
Pesticides	Commonly used on-base in the past



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Recommended preliminary m



preliminary monitoring well locations at Twin Cities AFRB.

FIGURE 11.

2. The details of the monitoring program, including the specific locations of ground-water monitoring wells, will be finalized as part of the Phase II program.
3. In the event that contaminants are detected, a more extensive field survey program should be implemented to determine the extent of contaminant migration.

B. OTHER RECOMMENDATIONS

In addition to the limited Phase II monitoring, it is recommended that the following program be conducted by the base.

1. The six out-of-service transformers located in the open field across from Building No. 752 should be either moved to a limited access area or fenced in. This precaution would help eliminate the potential of a transformer oil spill.
2. The commingling of waste oils and spent solvents (especially chlorinated hydrocarbons) is an unacceptable practice and the waste materials should be segregated.
3. All underground storage tanks used for the storage of waste materials should be leak tested (e.g. pressure checked) on a periodic basis.

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GLOSSARY OF TERMS

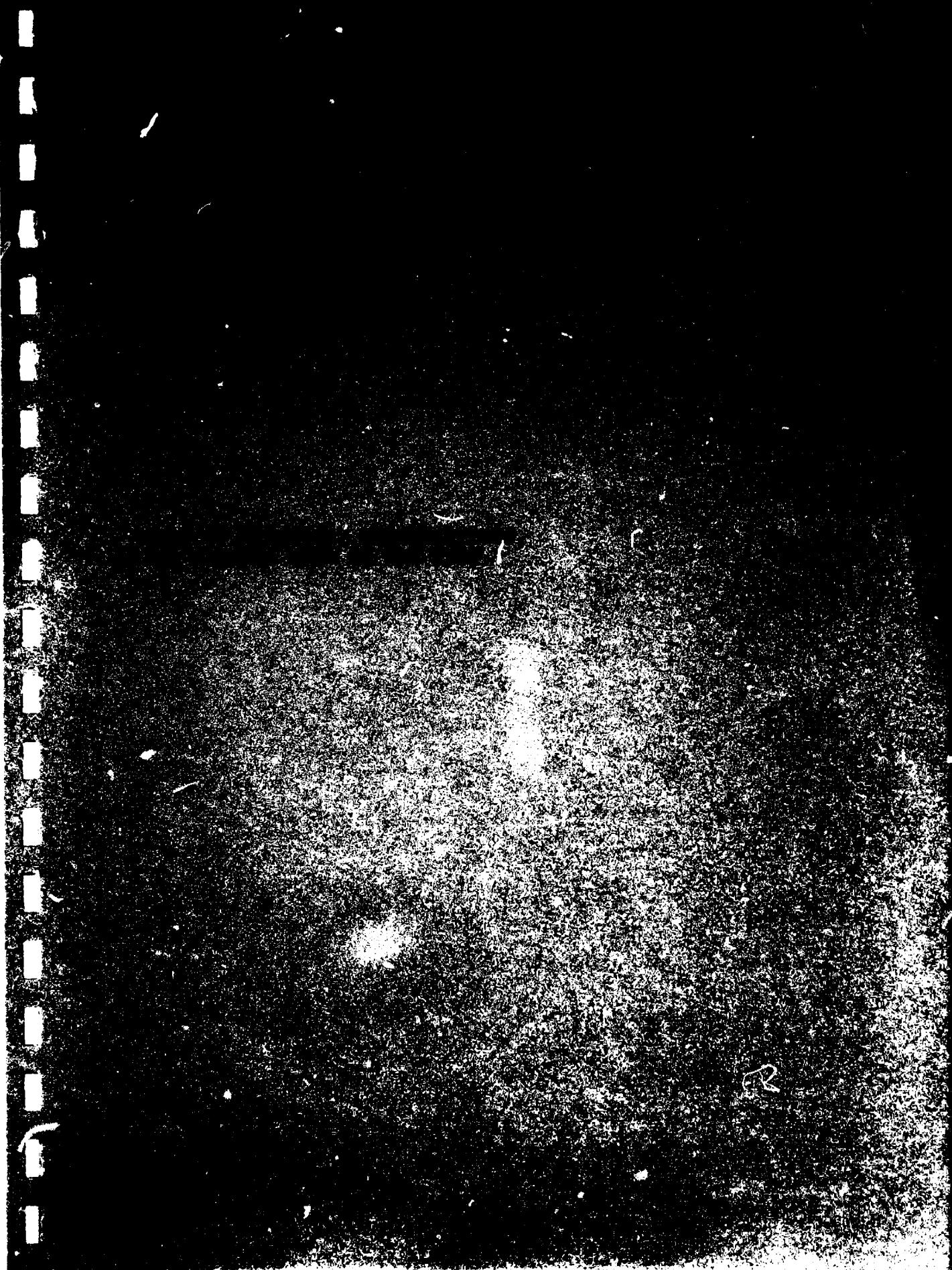
1. ALLUVIUM - A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semisorted sediment in the bed of the stream or on its flood plain or delta.
2. AQUIFER - A geologic formation, or group of formations, that contains sufficient saturated permeable material to conduct ground water to yield economically significant quantities of ground water to wells and springs.
3. CONFINING STRATA - A strata of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.
4. CONTAMINANT - As defined by section 104(a)(2) of CERCLA, shall include, but not be limited to, any element, substance, compound, or mixture, including disease causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformation, in such organisms or their offspring.
5. DOWNGRADIENT - A direction that is hydraulically down slope.

6. EVAPOTRANSPIRATION - Evaporation from the ground surface and transpiration through vegetation.
7. FLOOD PLAIN - The relatively smooth valley floors adjacent to and formed by alluviating rivers which are subject to overflow.
8. FRIABLE - Condition of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder.
9. GROUND WATER - All subsurface water, especially that part that is in the zone of saturation.
10. HAZARDOUS WASTE - A solid waste which because of its quantity, concentration, or physical, chemical or infectious characteristics may -
 - (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness; or
 - (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed.
11. LEACHING - The separation or dissolving out of soluble constituents from a rock or ore body by percolation of water.
12. LOAM - A rich, permeable soil composed of a friable mixture of relatively equal and moderate proportions of clay, silt, and sand particles, and usually containing

organic matter (humus) with a minor amount of gravelly material.

13. MAGNUSOL 747 - An emulsion type aircraft cleaning solvent (MIL-C-43616; Magnus Division, Economics Lab, Inc., St. Paul, Minnesota).
14. MIGRATION (Contaminant) - The movement of contaminants through pathways (ground water, surface water, soil, and air).
15. NET PRECIPITATION - Mean annual precipitation minus mean annual evapotranspiration.
16. OUTWASH PLAIN - A broad, outspread, flat or gently sloping, alluvial sheet of outwash deposited by meltwater streams flowing in front of or beyond the terminal moraine of a glacier.
17. PD 680 (Type I and Type II) - A petroleum distillate used as a safety cleaning solvent. The primary difference between PD 680 Type I and Type II is the flash point of the material. The flash points are 100°F and 140°F for PD 680 Types I and II, respectively.
18. PERMEABILITY - The capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment of the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.
19. POTENTIOMETRIC SURFACE - An imaginary surface that represents the static head of ground water and is defined by the level to which water will rise in a cased well.
20. STRATA - Distinguishable horizontal layers separated vertically from other layers.

21. TERRACE - Any long, narrow, relatively level or gently inclined surface, generally less broad than a plain, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope; a large bench or step-like ledge breaking the continuity of a slope.
22. UNSATURATED ZONE (Zone or Aeration) - A subsurface zone containing water under pressure less than that of the atmosphere, including water held by capillarity; and containing air or gases generally under atmospheric pressure. This zone is limited above the land surface and below the surface of the zone of saturation.
23. UPGRADIENT - A direction that is hydraulically up slope.
24. WATER TABLE - The upper limit of the portion of the ground wholly saturated with water.
25. WETLAND - An area subject to permanent or prolonged inundation or saturation which exhibits plant communities adapted to this environment.



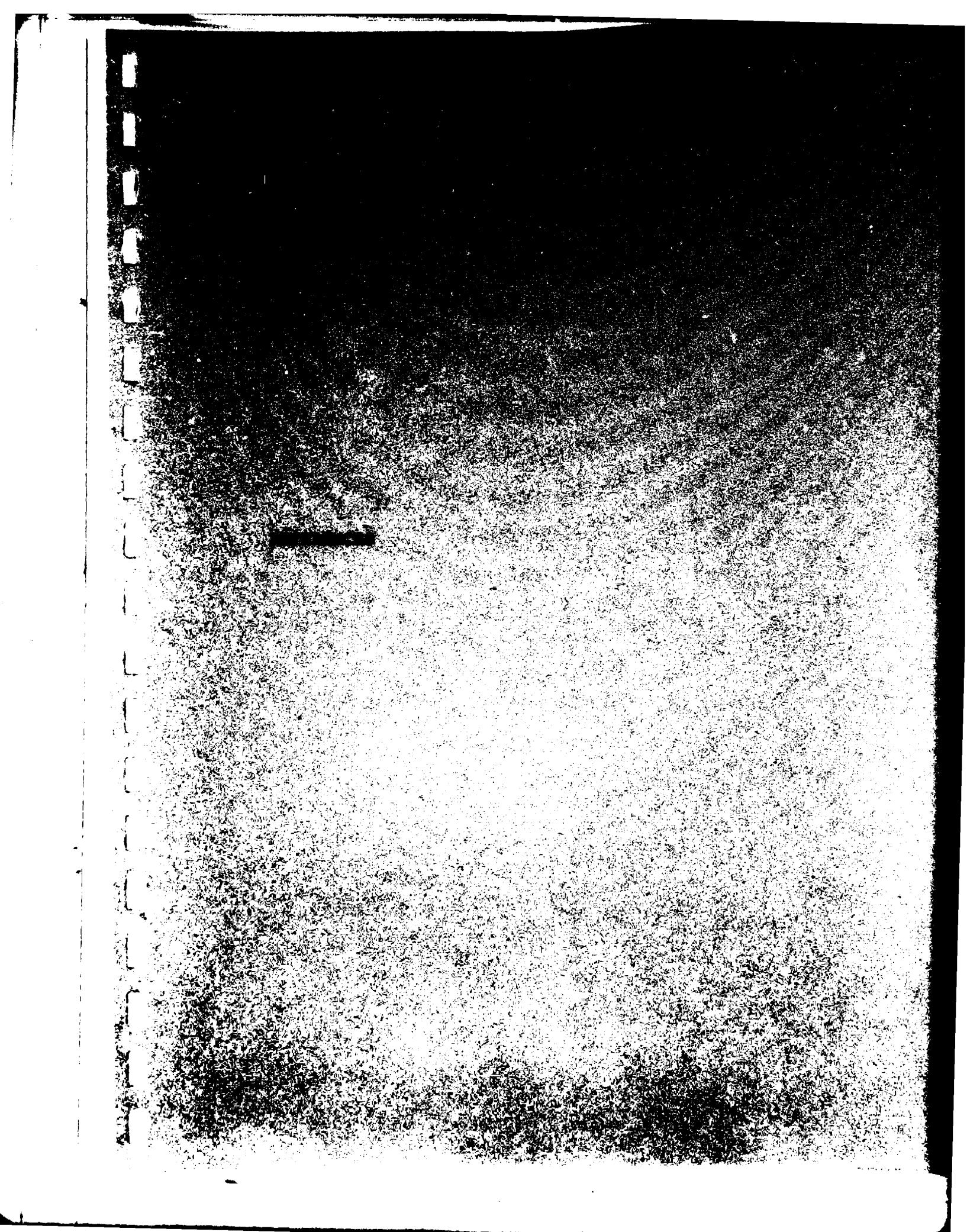


LIST OF ACRONYMS, ABBREVIATIONS,
AND SYMBOLS USED IN THE TEXT

AFESC	Air Force Engineering and Services Center
AFRB	Air Force Reserve Base
AFRES	Air Force Reserve
AGE	Aerospace Ground Equipment
AVGAS	Aviation Gasoline
bbl	Barrel
Bldg.	Building
bls	Below Land Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cm/s	Centimeters per Second
COD	Chemical Oxygen Demand
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DoD	Department of Defense
DPDO	Defense Property Disposal Office
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
°F	Degrees Fahrenheit
ft/day	Feet per Day
ft/ft	Feet per Foot
ft/min	Feet per Minute
gal	Gallons
gal/mo	Gallons per Month
gal/yr	Gallons per Year
gpd	Gallons per Day
gpm	Gallons per Minute
HARM	Hazard Assessment Rating Methodology
in	Inches
IRP	Installation Restoration Program
JP	Jet Petroleum
lb/yr	Pounds per Year

ACRONYMS--continued

Max.	Maximum
MEK	Methyl Ethyl Ketone
mg/l	Milligrams per Liter
mgd	Million Gallons per Day
mo.	Month
MOGAS	Motor Gasoline
msl	Mean Sea Level
NDI	Non-Destructive Inspection
No.	Number
NPDES	National Pollutant Discharge Elimination System
OEHL	Occupational and Environmental Health Laboratory
PCB	Polychlorinated Biphenyls
PD 680	Petroleum Distillate
POL	Petroleum, Oil, and Lubricants
PPM	Parts per Million
RCRA	Resource Conservation and Recovery Act
TAG	Tactical Airlift Group
TCE	Trichloroethylene
USAF	United States Air Force



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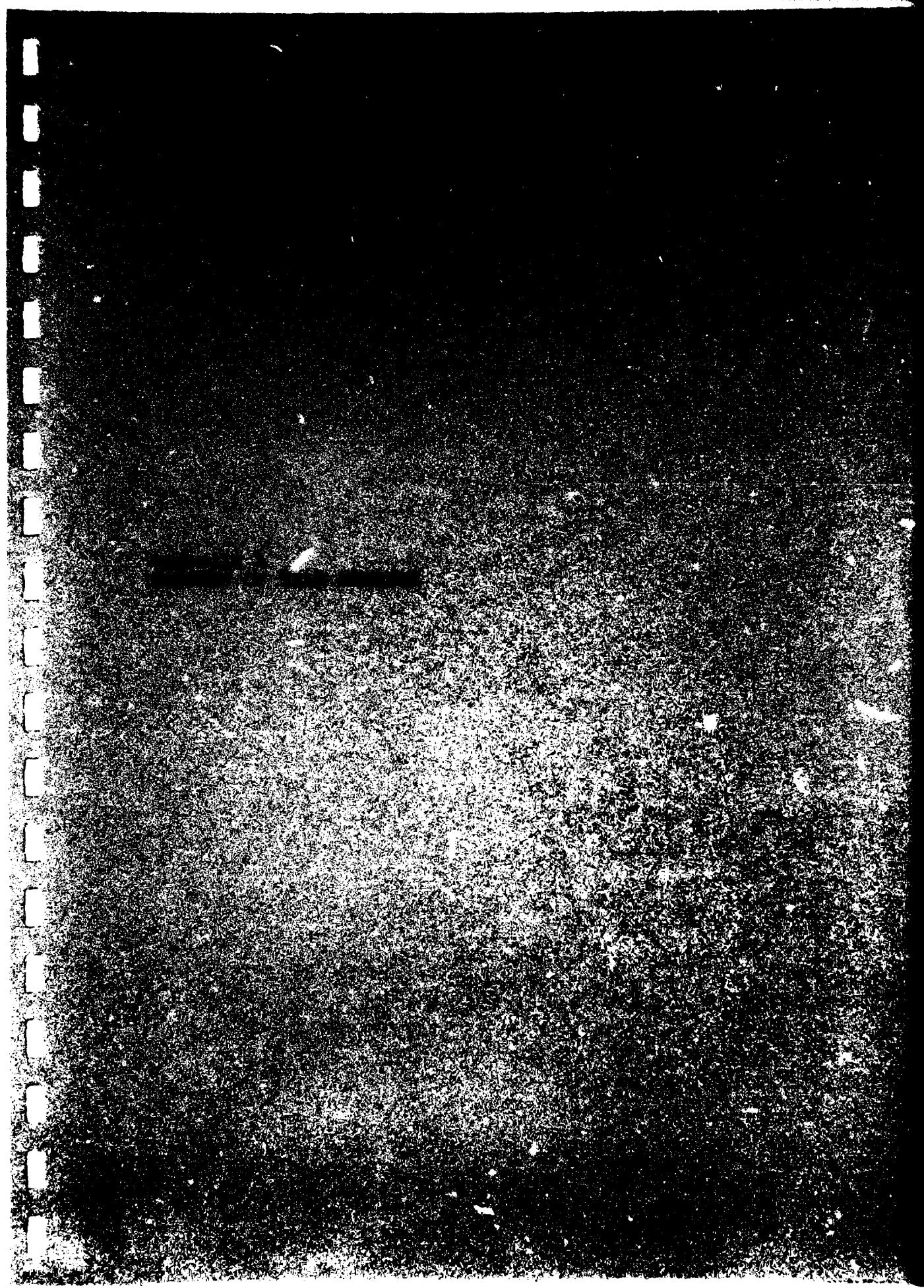
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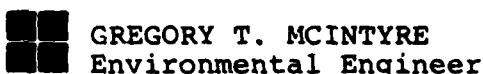
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Education

M.S., Environmental and Water Resources Engineering,
Vanderbilt University, 1981
B.S., Environmental Engineering, University of Florida, 1980

Experience

Mr. McIntyre is a project engineer in CH2M HILL's Industrial Processes Division, the Department of Solid and Hazardous Waste. His responsibilities involve projects dealing with hazardous waste management, industrial waste treatment processes, and laboratory and pilot plant treatability studies.

Mr. McIntyre participated in the wastewater characterization, laboratory bench-scale treatability study, evaluation of existing pretreatment facilities, and conceptual design for the equalization and aerobic biological treatment of industrial wastewater for Hercules, Inc. (6/82)

Mr. McIntyre has participated in hazardous materials disposal site records searches for 5 U.S. Air Force installations throughout the United States. The purpose of the records searches is to assess the potential for hazardous contaminant migration from past disposal practices and to recommend follow-up actions. (12/82)

Mr. McIntyre participated in the physical, chemical, and biological monitoring study of the effluent discharge mixing zone and the evaluation of the wastewater treatment system performance for Air Products and Chemicals, Inc., Escambia Plant. (6/82)

Mr. McIntyre participated in the compilation and evaluation of existing ground-water data for Phase I of the Biscayne Aquifer/Dade County Superfund hazardous waste study. (6/82)

Before joining CH2M HILL in September 1981, Mr. McIntyre worked as a research assistant in graduate school and one of his activities included researching the removal of heavy metals, including copper, zinc and trivalent chromium, using a large-scale adsorbing colloid foam flotation pilot plant.

Professional Registration

Engineer-In-Training, Florida

GREGORY T. MCINTYRE

Membership in Organizations

American Society of Civil Engineers
American Water Works Association
Water Pollution Control Federation
Florida Pollution Control Federation
Tau Beta Pi

Publications

"Inexpensive Heavy Metal Removal By Foam Flotation." (Coauthors E.L. Thackston, J.J. Rodriguez, and D. J. Wilson). Proceedings of the 35th Annual Purdue Industrial Waste Conference, May 1981. Proceedings of the International Conference on Heavy Metals in the Environment, Amsterdam, September 1981. Proceedings of the 2nd Mediterranean Congress of Chemical Engineering, Barcelona, Spain, October 1981.

"Copper Removal by an Adsorbing Colloid Foam Flotation Pilot Plant." (Coauthors E. L. Thackston, J.J. Rodriguez, and D.J. Wilson). Separation Science and Technology, 17(2), 1982.

"Experimental Verification of the Mathematical Model of a Continuous Flow Flotation Column." (Coauthors J. E. Kiefer, J.J. Rodriguez, and D. J. Wilson). Separation Science and Technology, 17(3), 1982.

"Pilot Plant Studies of Copper, Zinc, and Trivalent Chromium Removal By Adsorbing Colloid Foam Flotation." (Coauthors E.L. Thackston, J.J. Rodriguez, and D. J. Wilson). Tennessee Water Resources Research Center, Research Report No. 88, August 1981.

"Pilot Plant Study of Copper, Zinc, and Trivalent Chromium Removal by Adsorbing Colloid Foam Flotation." M.S. Thesis, Vanderbilt University, 1981.

■ GARY E. EICHLER
Hydrogeologist

Education

M.S., Engineering Geology, University of Florida, 1974
B.S., Construction and Geology, Utica College of Syracuse
University, 1972

Experience

Mr. Eichler has been responsible for ground-water projects for both water supply and effluent disposal. Studies have included site selection, well design, construction services, monitoring and testing programs, determination of aquifer characteristics, and well field design. In addition, Mr. Eichler has conducted numerous studies to determine pollution potential of toxic and hazardous wastes. Types of projects for which Mr. Eicher has been directly responsible for include:

- Exploration drilling, testing, and design of well fields for potable water supply with an installed capacity of over 65 mgd.
- Determination of pollutant travel time and direction of movement at hazardous waste disposal sites.
- Geophysical logging and testing programs for deep disposal wells for both municipal and hazardous waste.
- Aquifer modeling studies completed to predict effects of future ground-water withdrawal.
- Determination of saltwater intrusion potential and design of associated monitoring programs.

Prior to joining CH2M HILL in 1976, Mr. Eichler was an engineering geologist with Environmental Science and Engineering, Inc., of Gainesville, Florida. Responsibilities there included project management, soils investigations, siting studies, ground-water and surface-water reports, and Federal and state environmental impact studies. He has professional capabilities in the following areas.

- Hydrogeology. Water supply well location, aquifer testing, well field layout, injection well testing and monitoring program design, and well construction inspection.
- Water resources inventory. Potentiometric mapping, water yield, and availability determinations.
- Site investigations. Determination of subsurface conditions, primarily in soil media. Determination of stratigraphic correlation and associated physical properties for engineering design.
- Environmental permitting. Federal, state, regional, and local permit studies associated with industrial and mining projects.

GARY E. EICHLER

- Clay mineralogy. Clay mineral reactions primarily associated with lime stabilization for highways and other engineering projects. Participated in a Brazilian highway project and developed laboratory analysis for lime-soil reactions.
- Engineering geology. Geologic exploration, soil property determinations for engineering design, and water and earth materials interactions associated with construction.
- Geophysics. Well logging and interpretation.

Mr. Eichler directed the laboratory analysis of tropical soils to determine engineering properties and reaction potential with lime additives for a Brazilian highway project. He also assisted in the preparation and presentation of a seminar on lime stabilization sponsored by the National Lime Association.

Membership in Organizations

American Institute of Professional Geologists
American Water Resources Association
Association of Engineering Geologists
Geological Society of America
Southeastern Geological Society
National Water Well Association

Publications

Engineering Properties and Lime Stabilization of Tropically Weathered Soils. M.S. thesis, Department of Geology, University of Florida. August 1974.

Certifications

Certified Professional Geologist
Certificate No. 4544

■ **BRIAN H. WINCHESTER**
Department Manager, Environmental Sciences

Education

B.S., Wildlife Ecology, University of Florida, 1973

Experience

Mr. Winchester has broad experience in study design and implementation of field sampling programs, data interpretation, impact assessment and prediction, impact mitigation and remedial method development, report preparation and review, and expert consultation at client/agency hearings. He has successfully prepared numerous Environmental Impact Statements (EIS's), Developments of Regional Impact (DRI's), and environmental assessments for a variety of industries, utilities, and public agencies.

- EIS Studies—Designed and directed terrestrial and wetland biology studies for alternative Trident Submarine Base sites in Florida, Georgia, South Carolina, Virginia, and Rhode Island. Conducted biota inventories and assessed impacts of maintenance dredging along the 300-mile Gulf Intracoastal Waterway, Louisiana. Mapped biotic communities and assessed impacts of watercourse channelization on the 9-square-mile California Lake Watershed, Florida.
- DRI Studies—Managed or assisted in preparing five phosphate mine DRI's in central Florida. Helped develop mining and reclamation plans and provided technical input at client/agency hearings. Also provided biological baseline and impact assessment data for beneficiation plant sitings. Conducted biotic community inventories, delineated wetlands, and prepared DRI's for three proposed residential developments in central and southern Florida.
- Wetlands Studies—Assessed capacity of a 450-acre swamp in northeastern Florida to assimilate secondarily treated sewage. Investigated feasibility of enhancing a 30,000-acre marsh in northern Florida and wet prairie wetlands in southern Mississippi with municipal wastewater. Assessed impacts of water-table drawdown on Florida wetland vegetation in Palm Beach and Pasco Counties. Developed cost-effective, time-effective methodology for estimating the ecological value of freshwater wetlands and applied the technique to over 800 wetlands in central peninsular Florida; prepared wetland maps for Pasco, Pinellas, Hillsborough, Manatee, and Collier Counties; and assessed potential dredge and fill impacts on numerous wetlands.
- Industry Studies—Managed two 2-year biological monitoring studies assessing potential impacts of industrial effluents in upper Escambia Bay, Florida. Conducted baseline terrestrial and estuarine aquatic quarterly sampling for a proposed clean fuels facility in Jacksonville, Florida. Assessed impacts of oil and gas industry development in Tampa Bay area. Predicted SO₂ and NO_x air emission impacts on vegetation for a proposed caprolactam facility in southern Alabama.

BRIAN H. WINCHESTER

- Hazardous Waste Studies—Assessed ecological impacts associated with hazardous substances and their disposal at 13 USAF installations located throughout the U.S.
- Power Plant Studies—Studied aquatic biota entrained at a Miami generating station. Assessed impacts of blowdown on plant communities surrounding two Florida generating stations. Assessed alternative transmission line ROW's in Alachua County. Assisted in delineation of biotic communities for a generating station expansion in Crystal River, Florida. Prepared environmental assessments for siting power plants in western and northeastern Washington.
- Transportation/Corridor Studies—Evaluated biological impacts associated with alternative routings of major new highways in Pinellas and Duval Counties, Florida. Assessed environmental impacts of upgrading a telephone communications corridor extending from Windermere to Tampa. Prepared an ecological assessment for a proposed interstate highway interchange in Flagler County.
- Rare and Endangered Biota Research—Managed research on the ecology and management of a recently rediscovered endangered mammal. Conducted numerous endangered biota inventories.

Membership in Organizations

Society of Wetland Scientists
Ecological Society of America

City of Gainesville Hazardous Materials and Water Quality Committees

Publications

Mr. Winchester has authored several technical papers on wetland ecology, rare and endangered species management, and other topics. Representative papers include the following:

"Assessing Ecological Value of Central Florida Wetlands: A Case Study." *Proceedings of the Eighth Annual Conference on the Restoration and Creation of Wetlands* pages 25-38. 1981.

"Valuation of Coastal Plain Wetlands in the Southeastern United States." *Symposium on Progress in Wetlands Utilization and Management* (in press). 1981.

"Ecology and Management of the Colonial Pocket Gopher: A Progress Report," (with R. S. DeLotelle, J. R. Newman, and J. T. McClave). *Proceedings of the Rare and Endangered Wildlife Symposium*, Athens, Georgia. pp. 173-184. 1978.

"The Ecological Effects of Arsenic Emitted From Non-Ferrous Smelters," (with F. E. Benenati and T. P. King). U.S. EPA, EPA 560/6-77-011. 1976.

~~CONFIDENTIAL~~ CONTACT LIST

**■ Appendix B
OUTSIDE AGENCY CONTACT LIST**

1. U. S. Geological Survey
St. Paul, Minnesota
Mr. Michael E. Schdenberg
Mr. Henry W. Anderson
612/725-7841
2. Minnesota Geological Survey
St. Paul, Minnesota
Mr. Roman Kanivetsky
612/373-3372
3. U.S.D.A. Soil Conservation Service
St. Paul, Minnesota
612/725-7675
4. U.S. Fish and Wildlife Service
Regional Office
St. Paul, Minnesota
612/725-3596
5. U.S. Fish and Wildlife Service
Area Office
St. Paul, Minnesota
Mr. Jim Leach
612/725-7131
6. North Central Forest Experiment Station
St. Paul, Minnesota
Ms. Marcia Schardin
612/642-5207
7. N.O.A.A. National Weather Service
St. Paul, Minnesota
Mr. Mike Morgan
612/725-6090
8. N.O.A.A. National Climatic Center
Asheville, North Carolina
Mr. V. Cinquemani
Ms. Marjori McGuick
704/258-2850
9. Army Corps of Engineers
Permit Evaluation Section
Mr. Tim Fell
612/725-7775

10. U. S. Fish and Wildlife Service
Minnesota Valley National Wildlife Refuge
St. Paul, Minnesota
Mr. Tom Larson
612/854-5900
11. Minnesota Pollution Control Agency
Solid and Hazardous Waste Division
St. Paul, Minnesota
Mr. Bruce Wilson
Mr. Doug Day
612/297-3365
612/297-2704
12. Minnesota Pollution Control Agency
Water Quality Division
St. Paul, Minnesota
Mr. Dick Cable
Mr. Bob Dullinger
612/296-7235
13. Department of Natural Resources
Fort Snelling State Park
Hennepin County, Minnesota
Mr. David Novitzki
612/727-1961
14. Department of Natural Resources
Division of Fish and Wildlife, Ecological Services
St. Paul, Minnesota
Mr. Jack Enblom
Mr. P. Renard
612/296-2835
15. Hennepin County Environment and Energy Department
Hennepin County, Minnesota
Mr. Greg Lie
612/935-3381
16. Department of Natural Resources
Minnesota Natural Heritage Program
St. Paul, Minnesota
Ms. Barbara Coffin
612/296-3344
17. Hennepin County Department of Public Works
Environmental Services Division
Hennepin County, Minnesota
Mr. Ed Monteleone
612/935-3381

Appendix C
TWIN CITIES AFRB RECORDS SEARCH
INTERVIEW LIST

Appendix C
TWIN CITIES AFRB RECORDS SEARCH INTERVIEW LIST

<u>Interviewee</u>	<u>Area of Knowledge</u>	<u>Years at Installation</u>
1	Base History	24
2	Environmental Health	5
3	Fuels Maintenance	34
4	Roads and Grounds	26
5	Roads and Grounds	31
6	Aircraft Maintenance	29
7	Aircraft Maintenance	29
8	Aircraft Maintenance	27
9	Boiler Plant	18
10	Electrician	30
11	Entomology	15
12	Aircraft Maintenance	31
13	Aircraft Maintenance	31
14	Aircraft Maintenance	25
15	Aircraft Maintenance	30
16	Vehicle Maintenance	24
17	Vehicle Maintenance	24
18	Aircraft Maintenance	25
19	Aircraft Maintenance	25
20	Supply Management	31
21	Supply Management	24
22	Resources Administration	24
23	Bioenvironmental Engineering	4
24	Corrosion Control	12
25	Corrosion Control	6
26	Navy Air Reserve Operations	4
27	Navy Air Reserve Operations	4
28	Navy Air Reserve Operations	4
29	Navy Air Reserve Operations	1
30	Environmental Coordination	1
31	Civil Engineering	8
32	Aerospace Ground Equipment	21
33	Aircraft Maintenance	22
34	Aircraft Maintenance	20
35	Non-Destructive Inspection	4
36	Battery Shop	13
37	Aircraft Maintenance	12
38	Aircraft Maintenance	5
39	Aircraft Maintenance	12
40	Paint Shop	15

APPENDIX D
INSTALLATION HISTORY



Appendix D INSTALLATION HISTORY

Air operations at the Twin Cities AFRB were begun with the acquisition of 33.8 acres by the Federal Government for establishment of an Air Force Flight Training Base at the Wold Chamberlain Field, the municipal airport. The acquisition was accomplished in October, 1943. In 1944, an aircraft hangar parking apron and several temporary buildings were constructed in the area now known as Area C. A tornado struck this area in July of 1951 causing extensive damage to existing facilities. Subsequent major repair and construction programs necessitated by the storm were completed during the fall and winter of 1951.

In February of 1952, the Air Defense Command assumed jurisdiction of the installation and initiated a construction program during 1953 and 1954 in the area now known as Area D. A series of aircraft accidents causing several military and civilian deaths caused considerable public controversy in 1956 and 1957. The controversy resulted in Air Defense Command transferring to Duluth, Minnesota.

In January of 1958, the Continental Air Command (now known as the Air Force Reserve) assumed jurisdiction of the base and the mission changed to reserve training. In 1969, the 934th TAG assumed operational and support functions and became the host unit at Twin Cities AFRB.

For several years the 934th TAG was divided between Areas C and D. In November of 1969, the deactivation of the Twin Cities Naval Air Station was announced. The Air Force Reserve then acquired the Navy installation to consolidate

its activities at one location now referred to as Area N. The final transfer of the Navy property was accomplished in July of 1972.

Primary Mission

The 934th TAG is the current host unit at Twin Cities AFRB. The primary mission is to provide command and staff supervision over a "mission" squadron and its support units. This includes a Tactical Airlift Group for air transportation of airborne forces and their equipment and supplies; and material support, including supply services and organizational and field maintenance of assigned aircraft.

Tenant Mission

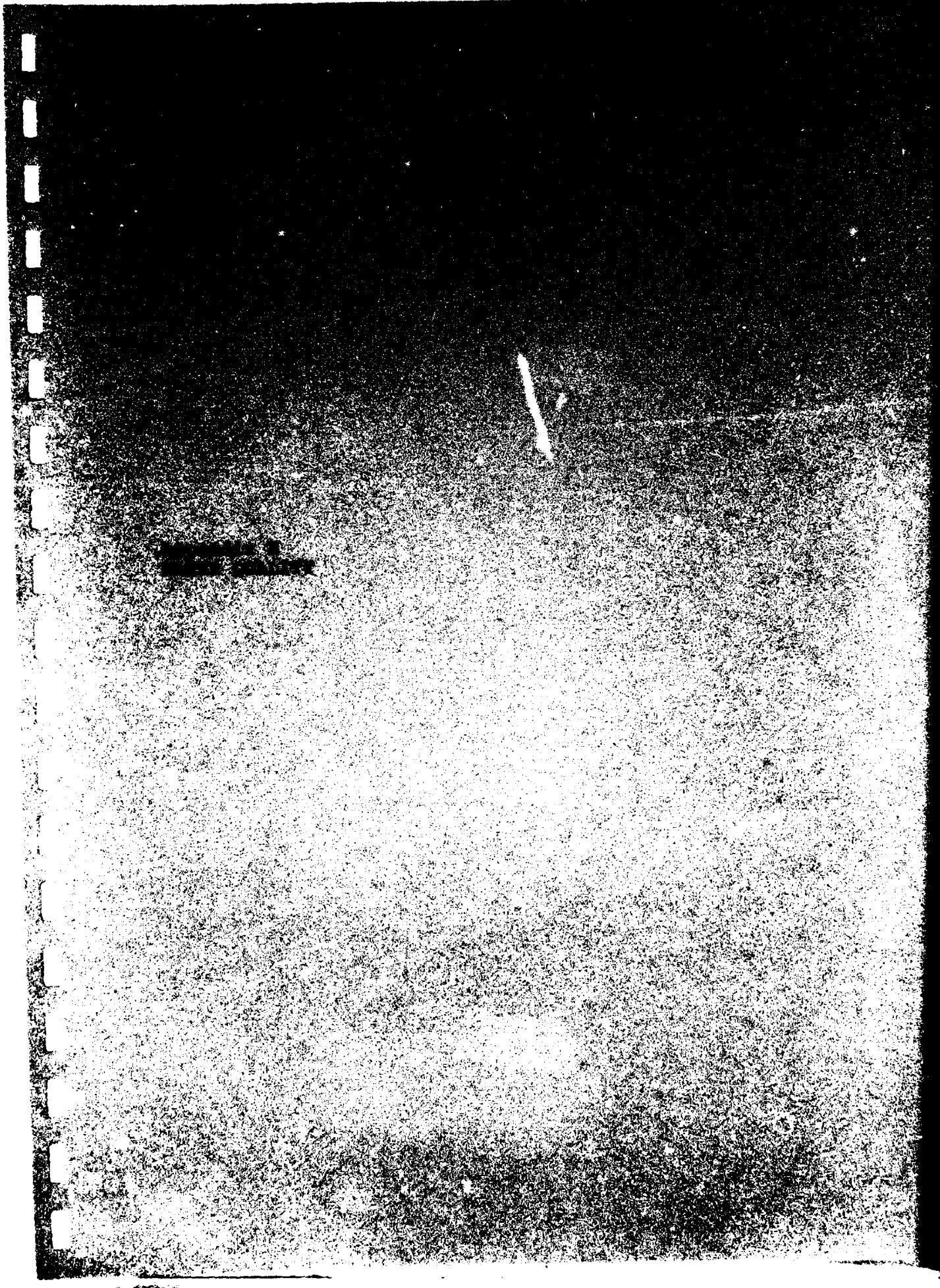
The major tenants at Twin Cities AFRB and their mission are summarized below:

133rd Tactical Airlift Wing, Minnesota Air National Guard--This base tenant provides command staff supervision of Tactical Airlift Groups. These groups provide the tactical airlift of airborne forces, equipment, and supplies and provide aeromedical evacuation. Three additional units attached to the 133rd Tactical Airlift Wing include the 237th Flight Facilities Flight, the 210th Electronic Installations Squadron, and the 133rd Field Training Flight.

Navy Air Reserve--This tenant unit manages assigned resources in such a manner as to maintain Naval Air Reserve units and personnel in a training readiness and available for augmentation. The Navy Air Reserve has no aircraft assigned at this installation.

Marine Reserve--This tenant unit coordinates, supervises, and supports the accomplishment of requisite training for attached organized reserve units. This unit supervises premobilization planning and logistics functions to insure orderly mobilization with time and readiness levels prescribed by current plans. The Marine Reserve has no aircraft assigned at this installation.

r69



Appendix E
WATER QUALITY CLASSIFICATIONS OF RIVER SEGMENTS
LOCATED AT THE BOUNDARY OF THE TWIN CITIES
AFRB STUDY AREA

<u>River Segment</u>	<u>Water Quality Standards</u>	
	<u>Limiting Standards</u>	<u>Other Uses</u>
Mississippi River		
St. Anthony Falls to Metropolitan Wastewater Treatment Plant (Water Quality Limited)	2B, 3B	2C, 3C, 4A, 4B, 5, 6
Minnesota River		
Carver Rapids to Mouth at Fort Snelling (Water Quality Limiting)	2C, 3B	3C, 4A, 4B, 5, 6

Appendix E
EXPLANATION OF WATER QUALITY CLASSIFICATIONS

<u>Use</u>	<u>Class A</u>	<u>Class B</u>	<u>Class C</u>	<u>Class D</u>
1. Domestic Consumption	Drinking quality maintained without any treatment	Drinking quality with approved disinfection	Drinking quality after treatment: coagulation, sedimentation, filtration, storage, chlorination	Drinking quality after treatment for Class C pre, post or intermediate treatment
2. Fisheries & Recreation	Quality permits propagation and maintenance of warm or cold water fish; suitable for all recreation including bathing	Quality permits propagation and maintenance of cool or warm water fish; suitable for all recreation including bathing	Quality permits propagation and maintenance of rough fish species; suitable for bathing	
3. Industrial Consumption	Quality suitable for use without chemical treatment except softening	Quality suitable for use after moderate treatment	Quality suitable for use for cooling and materials transport without high degree of treatment	
4. Agriculture and wildlife	Quality sufficient for irrigation	Quality sufficient for use by wildlife and livestock		
5. Navigation & Waste Disposal	Quality suitable for aesthetic enjoyment of scenery and to avoid any interference with navigation or property damage			
6. Other uses may be established as determined necessary.				

Source: Pollution Control Agency, 1973.

Appendix E
WATER QUALITY DATA^a

<u>Parameter</u>	<u>Mississippi^b River</u>	<u>Minnesota^c River</u>
Dissolved Oxygen	5-10 mg/l	+5 mg/l
Biochemical Oxygen Demand	4-8 mg/l	0-10 mg/l
Total Dissolved Solids	10-20,000 Tons/Day	--
Turbidity	<20 JTU	50-100 JTU
Fecal Coliform	300-4,000 MPN/100 ml	<200 MPN/100 ml

^aSource: Water Quality Report, Metropolitan Waste Control Commission.

^bSamples collected from Ford Dam, Mississippi River Mile 847.7.

^cComposite samples collected from four points along the Minnesota River, 36.0, 25.1, 14.3, and 3.5 miles upstream from the confluence of the Mississippi and Minnesota Rivers.

APPENDIX D
REGULATORY OF INDUSTRIAL
STANDARDS

Appendix F
MASTER LIST OF INDUSTRIAL OPERATIONS

Shop Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Waste	Current Treatment/Storage/Disposal Methods		
934th Tactical Airlift Group						
AGE Maintenance Shop	820	x	x	DPDO; supplemental fuel in Area C heating plant		
Battery Shop	822	x	x	Neutralization to sanitary sewer		
Corrosion Control	813	x	x	DPDO		
Electrical Systems Shop	821	x	x	Consumed in use		
Environmental Shop	822	x	x	Consumed in use		
Flightline Maintenance	821	x	x	Oil/water separator to sanitary sewer; DPDO		
Fuel Cell	870	x	x	Oil/water separator to sanitary sewer		
Inspection Section	821	x	x	Oil/water separator to sanitary sewer; DPDO		
Instruments/Flight Control	821	x	x	Consumed in use		
Jet Engine Shop	822	x	x	DPDO		
Life Support	830					
Machine Shop	822	x	x	Consumed in use		
Metal's Processing/Welding Shop	822	x	x	DPDO; sanitary sewer		
NDI Lab	822	x	x	DPDO		
Pnedraulics Shop	822	x	x	DPDO		
Propeller Shop	822	x	x	Consumed in use		
Radio/Radar	821	x	x	DPDO; consumed in use		
Repair and Reclamation Shop	822	x	x	Consumed in use		
Structural Repair/Sheet Metal Shop	821	x	x	Consumed in use		
Survival Equipment Shop	830	x	x	Supplemental fuel in Area C heating plant		
Motor Vehicle Maintenance	803	x	x	Consumed in use		
Photo Lab	751	x	x	Fire department training exercises at MAC		
Fuel Systems	POL Tank Farm	x	x	DPDO		
Boiler Plant	812	x	x	Consumed in use		
Carpenter Shop	865	x	x	DPDO		
Civil Engineering Flight Mobility	861	x	x	Consumed in use		
Electric Shop	865	x	x	Consumed in use		
Heating and Air Conditioning	865	x	x	Fire department training exercises at MAC		
Paint Shop	865	x	x	Consumed in use		
Pavements and Grounds	865	x	x	Fire department training exercises at MAC		
Plumbing Shop	865	x	x	Consumed in use		
Sheet Metal Shop	865	x	x	Consumed in use		
Entomology Shop	802	x	x	Consumed in use		

^aRefer to Section IV-A-1, page IV-1 for information on past locations of industrial operations.

Appendix F--Continued

<u>Shop Name</u>	<u>Present Location^a (Bldg. No.)</u>	<u>Handles Hazardous Materials</u>	<u>Generates Hazardous Waste</u>	<u>Current Treatment/Storage/Disposal Methods</u>
Minnesota Air National Guard				
Personal Equipment	686	x	x	Contractor removal
Flightline Maintenance	680 ^b	x	x	DPDO
Corrosion Control	687 ^b	x	x	Contractor removal; fire department training exercises at MAC
Phase Inspection Dock	685	x	x	Consumed in use
Electric Shop	685	x	x	DPDO; fire department training exercises at MAC
Fuel Systems	685	x	x	
Material Control	685	x	x	
Machine Shop	687	x	x	Consumed in use
Sheet Metal Shop	687	x	x	
Welding Shop	687	x	x	
Environmental Systems	687	x	x	DPDO
Avionics Instrument Shop	680	x	x	Consumed in use
Pnedraulics	687	x	x	Contractor removal
Repair and Reclamation	685	x	x	
Propulsion Shop	687	x	x	Contractor removal; DPDO
ACE Maintenance	687	x	x	Contractor removal; consumed in use
NDI Shop	687	x	x	DPDO; consumed in use
POL Fuels Management	604	x	x	Fire department training exercises at MAC
Material Storage	616	x	x	
Traffic Management	616	x	x	
Surface Transportation/Motor Pool	662 ^c	x	x	Contractor removal
Battery Shop	662	x	x	Neutralization to sanitary sewer
Civil Engineering	612	x	x	Consumed in use
Medical-Dental X-ray	641	x	x	Consumed in use
Photo Lab	632	x	x	Consumed in use
133rd Communications Flight Repair Shop	644	x	x	
210th and 237th Electronic Shop	690	x	x	Consumed in use
Navy Air Reserve				
Ordnance Shop	P-1	x	x	Contractor removal
Electric Shop	P-1	x	x	
Ground Support Shop	P-1	x	x	Contractor removal
Metal Shop	P-1			
Marine Reserve				
Motor Pool	P-2	x	x	Contractor removal

^aRefer to Section IV-A-1, page IV-1 for information on past locations of industrial operations.

^bAll industrial operations located in Building No. 687 were located in Buildings No. 680 and 685 prior to 1979.

^cAll industrial operations located in Building No. 662 were located in Building No. 614 prior to 1977.

Appendix G
INVENTORY OF EXISTING
POL STORAGE TANKS

Appendix G
INVENTORY OF MAJOR EXISTING POL STORAGE TANKS

<u>Facility No.</u>	<u>Type POL</u>	<u>Capacity</u>	<u>Tank Type</u>
600	JP-4	6,000 bbl	AG
601	JP-4	5,000 bbl	AG
2701	Heating Fuel Oil	50,000 gal	UG
2710	Heating Fuel Oil	33,348 gal	UG
2711	Heating Fuel Oil	33,348 gal	UG
2712	Heating Fuel Oil	33,348 gal	UG
2713	Heating Fuel Oil	33,348 gal	UG
2750	JP-4	5,000 bbl	UG
2760	Diesel	1,500 gal	UG
2901	MOGAS	6,000 gal	UG
2901	Diesel	500 gal	UG
2901	MOGAS	10,000 gal	UG
2901	MOGAS	10,000 gal	UG
2902	Heating Fuel Oil	8,000 gal	UG
2902	Heating Fuel Oil	10,000 gal	UG
2902	Heating Fuel Oil	6,000 gal	UG
2902	Heating Fuel Oil	20,000 gal	UG
2902	Heating Fuel Oil	10,000 gal	UG
2903	Heating Fuel Oil	20,000 gal	UG
2903	Heating Fuel Oil	10,000 gal	UG
2904	Heating Fuel Oil	1,000 gal	UG
2905	Heating Fuel Oil	25,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG
Un-numbered	Heating Fuel Oil	4,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG
Un-numbered	Heating Fuel Oil	7,000 gal	UG
Un-numbered	Heating Fuel Oil	3,000 gal	UG
Un-numbered	Heating Fuel Oil	3,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG
Un-numbered	Heating Fuel Oil	10,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG
Un-numbered	Heating Fuel Oil	6,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG
Un-numbered	Heating Fuel Oil	6,000 gal	UG
Un-numbered	Heating Fuel Oil	2,000 gal	UG

NOTES: UG = Underground tank and AG = aboveground tank, Un-numbered heating fuel oil tanks installed to service individual boilers.

Appendix H
HAZARD ASSESSMENT RATING
METHODOLOGY

USAF INSTALLATION RESTORATION PROGRAM
HAZARD ASSESSMENT RATING METHODOLOGY

BACKGROUND

The Department of Defense (DoD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DoD facilities. One of the actions required under this program is to:

"develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from USAF Occupational and Environmental Health Laboratory (OEHL), Air Force Engineering and Services Center (AFESC), Engineering-Science (ES) and CH2M HILL. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering

Science, and CH2M HILL met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DoD program needs.

The model uses data readily obtained during the Record Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the

policy for evaluating and setting restrictions on excess DoD properties.

Site scores are developed using the appropriate ranking factors according to the method presented in the flow chart (Figure 1). The site rating form is provided in Figure 2 and the rating factor guidelines are provided in Table 1.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, the potential pathways for waste contaminant migration, and any efforts to contain the contamination. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant, and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface-water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories.

HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART

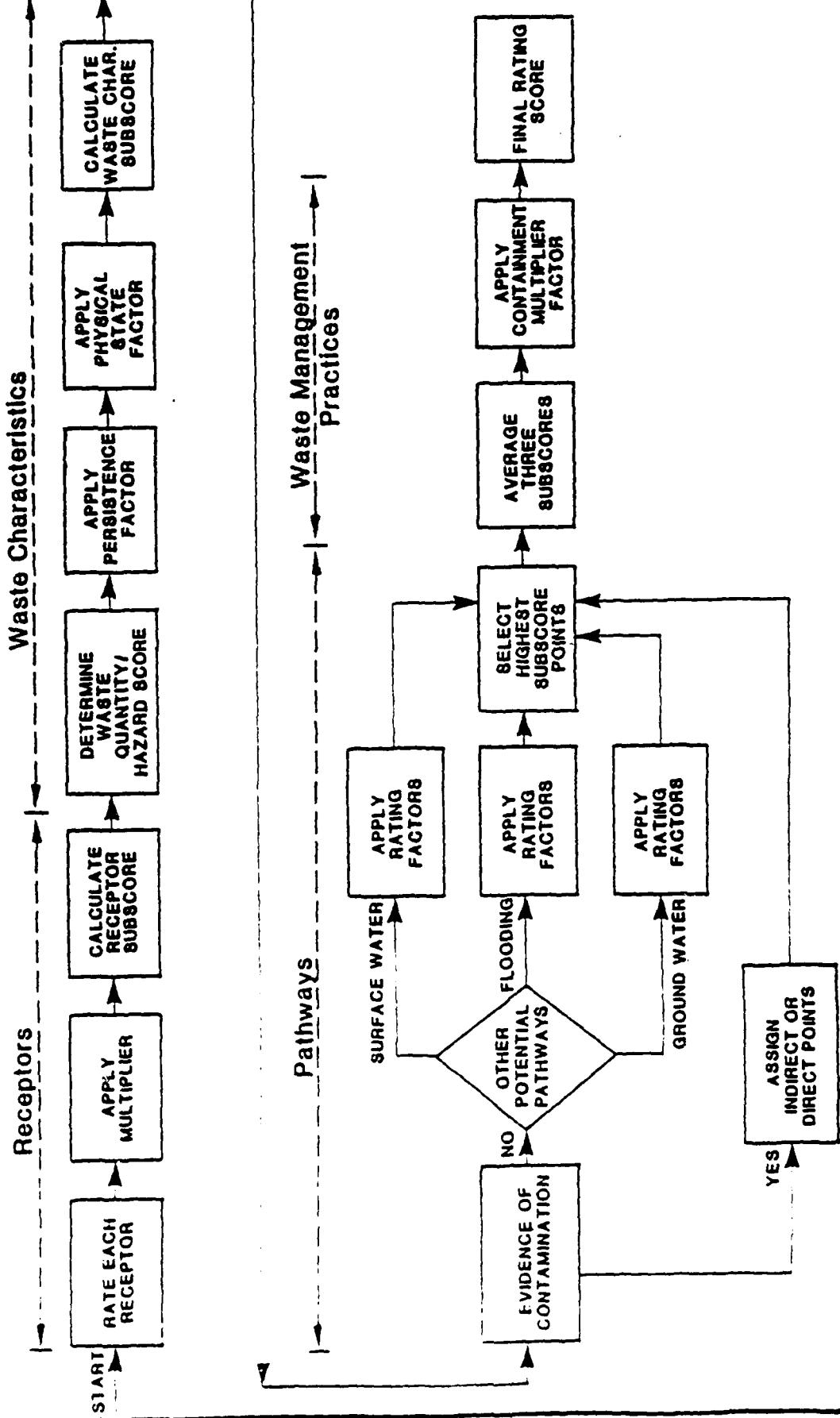


FIGURE 2

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE _____
 LOCATION _____
 DATE OF OPERATION OR OCCURRENCE _____
 OWNER/OPERATOR _____
 COMMENTS/DESCRIPTION _____
 SITE RATED BY _____

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multipplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		5		

Subtotals _____

Receptors Subscore (100 X Factor score subtotal/maximum score subtotal) _____

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) _____
2. Confidence level (C = confirmed, S = suspected) _____
3. Hazard rating (H = high, M = medium, L = low) _____

Factor Subscore A (from 20 to 100 based on factor score matrix) _____

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

_____ X _____ = _____

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

_____ X _____ = _____

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
Subscore _____				
B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.				
1. Surface water migration				
<u>Distance to nearest surface water</u>			8	
<u>Net precipitation</u>			6	
<u>Surface erosion</u>			8	
<u>Surface permeability</u>			6	
<u>Rainfall intensity</u>			8	
Subtotals _____				
Subscore (100 x factor score subtotal/maximum score subtotal) _____				
2. Flooding				
Subscore (100 x factor score/3) _____				
3. Ground-water migration				
<u>Depth to ground water</u>			8	
<u>Net precipitation</u>			6	
<u>Soil permeability</u>			8	
<u>Subsurface flows</u>			8	
<u>Direct access to ground water</u>			8	
Subtotals _____				
Subscore (100 x factor score subtotal/maximum score subtotal) _____				

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore _____

IV. WASTE MANAGEMENT PRACTICES**A. Average the three subscores for receptors, waste characteristics, and pathways.**

Receptors
Waste Characteristics
Pathways

Total _____ divided by 3 = _____

Gross Total Score _____

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

_____ X _____ = _____

Table 1
HAZARDOUS ASSESSMENT RATING METHODOLOGY GUIDELINES

1. RECEPTORS CATEGORY	Rating Factors	Rating Scale Levels			Multiplier
		0	1	2	
A. Population within 1,000 feet (includes on-base facilities)	0	1-25	26-100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land Use/Zoning (within 1-mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential	3
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E. Critical environments (within 1-mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands	10
F. Water quality/use designation of nearest surface water body	Agricultural or Industrial use	Recreation, propagation and management of fish and wildlife	Shellfish propagation and harvesting	Potable water supplies	6
G. Ground-water use of uppermost aquifer	Not used, other sources readily available	Commercial, industrial, or irrigation, very limited other water sources	Drinking water, no municipal water available	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1-15	51-1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1-50	51-1,000	Greater than 1,000	6

Table 1--Continued

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

S = Small quantity (5 tons or 20 drums of liquid)
 M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
 L = Large quantity (20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- o Verbal reports from interviewer (at least 2) or written information from the records
- o Knowledge of types and quantities of wastes generated by shops and other areas on base

S = Suspected confidence level

- o No verbal reports or conflicting verbal reports and no written information from the records
- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site

A-3 Hazard Rating

Rating Factors	Rating Scale Levels			<u>Points</u>
	0	1	2	
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2	Sax's Level 3
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F	Flash point less than 80°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels	Over 5 times background levels
Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.				
		Hazard Rating		
		High (H)	3	
		Medium (M)	2	
		Low (L)	1	

Table 1-Continued

II. WASTE CHARACTERISTICS--Continued

Waste Characteristics Matrix

<u>Point Rating</u>	<u>Hazardous Waste Quantity</u>	<u>Confidence Level of Information</u>	<u>Hazard Rating</u>
100	L	C	H
80	H	C	H
70	L	S	H
60	S	C	H
	H	C	H
50	L	S	H
	S	C	H
	S	S	H
40	H	C	H
	L	S	L
30	N	C	L
	S	S	N
20	S	S	L

B. Persistence Multiplier for Point Rating

Multiply Point Rating
Persistence CriteriaFrom Part A by the Following

- Metals, polycyclic compounds, and halogenated hydrocarbons
- Substituted and other ring compounds
- Straight chain hydrocarbons
- Easily biodegradable compounds

C. Physical State Multiplier

Physical StateMultiply Point Total From
Parts A and B by the Following

Liquid	1.0
Sludge	0.75
Solid	0.50

Notes:
 For a site with more than one hazardous waste, the waste quantities may be added using the following rules:
Confidence Level
 o Confirmed confidence levels (C) can be added.
 o Suspected confidence levels (S) can be added.
 o Confirmed confidence levels cannot be added with suspected confidence levels.
Waste Hazard Rating
 o Wastes with the same hazard rating can be added.
 o Wastes with different hazard ratings can only be added in a downgrade mode, e.g. MCM + SCH = LCM if the total quantity is greater than 20 tons.
Example: Several wastes may be present at a site, each having an MCM designation (60 points). By adding the quantities of each waste, the designation may change to LCM (80 points). In this case, the correct point rating for the waste is 80.

Table 1--Continued

III. PATHWAYS CATEGORYA. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 Potential for Surface Water Contamination

Rating Factors	Rating Scale Levels			Multiplier	
	0	1	2		
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet	3
Net precipitation	Less than -10 inches	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches	6
Surface erosion	None	Slight	Moderate	Severe	8
Surface permeability	0% to 15% clay (>10 ⁻² cm/sec)	15% to 30% clay (10 to 10 ⁻⁴ cm/sec)	30% to 50% clay (10 ⁻⁴ to 10 ⁻⁶ cm/sec)	Greater than 50% clay (>10 ⁻⁶ cm/sec)	6
Rainfall intensity based on 1-year 24-hour rainfall	<1.0 inch	1.0 to 2.0 inches	2.1 to 3.0 inches	>3.0 inches	8
<u>B-2 Potential for Flooding</u>					
Floodplain	Beyond 100-year floodplain	In 25-year floodplain	In 10-year floodplain	Floods annually	1
<u>B-3 Potential for Ground-Water Contamination</u>					
Depth to ground water	Greater than 500 feet	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 inches	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches	6
Soil permeability	Greater than 50% clay (>10 ⁻⁶ cm/sec)	30% to 50% clay (10 ⁻⁴ to 10 ⁻⁴ cm/sec)	15% to 30% clay (10 ⁻² to 10 ⁻⁴ cm/sec)	0% to 15% clay (<10 ⁻² cm/sec)	8

Table 1--Continued

B-3 Potential for Ground-Water Contamination--Continued

<u>Rating Factors</u>	<u>Rating Scale Levels</u>	<u>Multiplier</u>
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged
Direct access to ground water (through faults, fractures, faulty well casings, subsidence, fissures, etc.)	No evidence of risk	Bottom of site frequently submerged
	Low risk	Moderate risk

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. Waste Management Practices Factor

The following multipliers are then applied to the total risk points (from A):

<u>Waste Management Practice</u>	<u>Multiplier</u>
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Fire Protection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1, or III-6-3, then leave blank for calculation of factor score and maximum possible score.

CNR68A

Appendix I
SITE RATING FORMS

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE: Small Arms Range Landfill, Site No. 1
 LOCATION: Twin Cities AFRB, Area B
 DATE OF OPERATION OR OCCURRENCE: 1963 - 1972
 OWNER/OPERATOR: Twin Cities AFRB
 COMMENTS/DESCRIPTION: Base Landfill; AVGAS Sludge Disposal; Plant Filters
 SITE RATED BY: G. McIntyre

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface-water body	3	6	18	18
G. Ground-water use of uppermost aquifer	2	9	18	27
H. Population served by surface-water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	2	6	12	18
		Subtotals	122	180

Receptors subscore (100 x factor score subtotal/maximum subtotal) 68

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor
 Factor Subscore A x Persistence Factor = Subscore B
 $60 \times 1.0 = 60$

C. Apply physical state multiplier
 Subscore B x Physical State Multiplier = Waste Characteristics Subscore
 $60 \times 1.0 = \underline{\underline{60}}$

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
			Subscore	--
B. Rate the migration potential for three potential pathways: surface-water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.				
1. Surface-water migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	1	6	6	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding	1	1	30	100
		Subscore (100 x factor score/3)		30
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	1	6	6	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to ground water	N/A	8	--	--
		Subtotals	46	90
Subscore (100 x factor score subtotal/maximum score subtotal)				51
C. Highest pathway subscore				
Enter the highest subscore value from A, B-1, B-2, or B-3 above.				
		Pathways Subscore		51

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	68
Waste Characteristics	60
Pathways	51
Total 179 divided by 3 =	60
Gross Total	

B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

$60 \times 1.0 =$ 60

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE: MOCAS Spill, Site No. 4
 LOCATION: Twin Cities AFRB, Area D
 DATE OF OPERATION OR OCCURRENCE: 1958
 OWNER/OPERATOR: Twin Cities AFRB
 COMMENTS/DESCRIPTION: MOCAS Spill Near Building No. 614, Old Motor Pool
 SITE RATED BY: G. McIntyre

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface-water body	3	6	18	18
G. Ground-water use of uppermost aquifer	2	9	18	27
H. Population served by surface-water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	2	6	12	18
		<u>Subtotals</u>	<u>139</u>	<u>180</u>

Receptors subscore (100 x factor score subtotal/maximum subtotal) 77

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S2. Confidence level (C = confirmed, S = suspected) S3. Hazard rating (H = high, M = medium, L = low) HFactor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$40 \times 0.8 = 32$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$32 \times 1.0 = \underline{\underline{32}}$$

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
			Subscore	--
B. Rate the migration potential for three potential pathways: surface-water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.				
1. Surface-water migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	1	6	6	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding	0	1	0	100
		Subscore (100 x factor score/3)		0
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	1	6	6	18
Soil permeability	0	8	0	24
Subsurface flows	0	8	0	24
Direct access to ground water	N/A	8	--	--
		Subtotals	14	90
Subscore (100 x factor score subtotal/maximum score subtotal)				16
C. Highest pathway subscore				
Enter the highest subscore value from A, B-1, B-2, or B-3 above.			Pathways Subscore	48
IV. WASTE MANAGEMENT PRACTICES				
A. Average the three subscores for receptors, waste characteristics, and pathways.				
	Receptors			77
	Waste Characteristics			32
	Pathways			48
	Total 157 divided by 3 =			52
			Gross Total Score	

B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

$$52 \times 1.0 =$$

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE: Suspected POL Spill Area, Site No. 5
 LOCATION: Twin Cities AFRB, Area D
 DATE OF OPERATION OR OCCURRENCE: --
 OWNER/OPERATOR: Twin Cities AFRB
 COMMENTS/DESCRIPTION: Interviewees Reported Contaminated Soil
 SITE RATED BY: G. McIntyre

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface-water body	3	6	18	18
G. Ground-water use of uppermost aquifer	2	9	18	27
H. Population served by surface-water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	2	6	12	18
		<u>Subtotals</u>	<u>139</u>	<u>180</u>

Receptors subscore (100 x factor score subtotal/maximum subtotal) 77

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S2. Confidence level (C = confirmed, S = suspected) C3. Hazard rating (H = high, M = medium, L = low) MFactor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor
 Factor Subscore A x Persistence Factor = Subscore B

$$50 \times 0.8 = 40$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$40 \times 1.0 = \underline{\underline{40}}$$

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
			Subscore	--
B. Rate the migration potential for three potential pathways: surface-water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.				
1. Surface-water migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	1	6	6	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				0
2. Flooding	0	1	0	100
		Subscore (100 x factor score/3)	0	
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	1	6	6	18
Soil permeability	0	8	0	24
Subsurface flows	0	8	0	24
Direct access to ground water	N/A	8	--	--
		Subtotals	14	90
Subscore (100 x factor score subtotal/maximum score subtotal)				16
C. Highest pathway subscore				
Enter the highest subscore value from A, B-1, B-2, or B-3 above.				
		Pathways Subscore	<u>48</u>	
IV. WASTE MANAGEMENT PRACTICES				
A. Average the three subscores for receptors, waste characteristics, and pathways.				
Receptors			77	
Waste Characteristics			140	
Pathways			48	
Total 165 divided by 3 =			55	
				Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

55 x 1.0 =

55

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE: Liquid Sludge Burial Pit, Site No. 6

LOCATION: Twin Cities AFRB, Area D

DATE OF OPERATION OR OCCURRENCE: 1971

OWNER/OPERATOR: Twin Cities AFRB

COMMENTS/DESCRIPTION: Disposal of Liquid AVGAS Sludge Suspected

SITE RATED BY: G. McIntyre

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface-water body	3	6	18	18
G. Ground-water use of uppermost aquifer	2	9	18	27
H. Population served by surface-water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	2	6	12	18
		Subtotals	139	180

Receptors subscore (100 x factor score subtotal/maximum subtotal)

77

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

S

2. Confidence level (C = confirmed, S = suspected)

S

3. Hazard rating (H = high, M = medium, L = low)

H

Factor Subscore A (from 20 to 100 based on factor score matrix)

40

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$40 \times 1.0 = 40$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$40 \times 1.0 = \underline{\underline{40}}$$

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
B. Rate the migration potential for three potential pathways: surface-water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.			<u>Subscore</u>	--
1. Surface-water migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	1	6	6	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		<u>Subtotals</u>	44	108
Subscore (100 x factor score subtotal/maximum score subtotal)				41
2. Flooding	0	1	0	100
		<u>Subscore (100 x factor score/3)</u>		0
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	1	6	6	18
Soil permeability	0	8	0	24
Subsurface flows	0	8	0	24
Direct access to ground water	N/A	8	--	--
		<u>Subtotals</u>	14	90
Subscore (100 x factor score subtotal/maximum score subtotal)				16
C. Highest pathway subscore				
Enter the highest subscore value from A, B-1, B-2, or B-3 above.				
		<u>Pathways Subscore</u>		41

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	77
Waste Characteristics	40
Pathways	41
Total 158 divided by 3 =	53
Gross Total Score	

B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

53 x 1.0 =

53

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE: Past Fuel Spill Area, Site No. 7

LOCATION: Twin Cities AFRB, Area N

DATE OF OPERATION OR OCCURRENCE: --

OWNER/OPERATOR: Twin Cities AFRB

COMMENTS/DESCRIPTION: One Reported Spill Incident and Numerous Overtopping Spills

SITE RATED BY: G. McIntyre

I. RECEPTORS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface-water body	3	6	18	18
G. Ground-water use of uppermost aquifer	2	9	18	27
H. Population served by surface-water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	2	6	12	18
		<u>Subtotals</u>	<u>143</u>	<u>180</u>

Receptors subscore (100 x factor score subtotal/maximum subtotal) 79

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

M

2. Confidence level (C = confirmed, S = suspected)

S

3. Hazard rating (H = high, M = medium, L = low)

H

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$50 \times 0.8 = 40$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$40 \times 1.0 = \underline{\underline{40}}$$

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
			Subscore	--
B. Rate the migration potential for three potential pathways: surface-water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.				
1. Surface-water migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	1	6	6	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding	0	1	0	100
		Subscore (100 x factor score/3)		0
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	1	6	6	18
Soil permeability	0	8	0	24
Subsurface flows	0	8	0	24
Direct access to ground water	N/A	8	--	--
		Subtotals	14	90
Subscore (100 x factor score subtotal/maximum score subtotal)				26
C. Highest pathway subscore				
Enter the highest subscore value from A, B-1, B-2, or B-3 above.				
		Pathways Subscore	48	

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	79
Waste Characteristics	40
Pathways	48
Total 167 divided by 3 =	56
Gross Total Score	

B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

56 x 1.0 = 56

HAZARDOUS ASSESSMENT RATING FORM

Page 1 of 2

NAME OF SITE: Hazardous Storage Area, Site No. 8

LOCATION: Twin Cities AFRB, Area N

DATE OF OPERATION OR OCCURRENCE: 1981 - 1982

OWNER/OPERATOR: Twin Cities AFRB

COMMENTS/DESCRIPTION:

SITE RATED BY: G. McIntyre

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	3	10	30	30
F. Water quality of nearest surface-water body	3	6	18	18
G. Ground-water use of uppermost aquifer	2	9	18	27
H. Population served by surface-water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	2	6	12	18
		Subtotals	143	180

Receptors subscore (100 x factor score subtotal/maximum subtotal)

79

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large)

S

2. Confidence level (C = confirmed, S = suspected)

C

3. Hazard rating (H = high, M = medium, L = low)

M

Factor Subscore A (from 20 to 100 based on factor score matrix)

50

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$50 \times 0.8 = 40$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$40 \times 1.0 = \underline{\underline{40}}$$

III. PATHWAYS

<u>Rating Factor</u>	<u>Factor Rating (0-3)</u>	<u>Multiplier</u>	<u>Factor Score</u>	<u>Maximum Possible Score</u>
A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.				
			Subscore	--
B. Rate the migration potential for three potential pathways: surface-water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.				
1. Surface-water migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	1	6	6	18
Surface erosion	0	8	0	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
		Subtotals	52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding	0	1	0	0
		Subscore (100 x factor score/3)	30	
3. Ground-water migration				
Depth to ground water	1	8	8	24
Net precipitation	1	6	6	18
Soil permeability	0	8	0	24
Subsurface flows	0	8	0	24
Direct access to ground water	N/A	8	--	--
		Subtotals	14	90
Subscore (100 x factor score subtotal/maximum score subtotal)				16

C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 48**IV. WASTE MANAGEMENT PRACTICES****A. Average the three subscores for receptors, waste characteristics, and pathways.**

Receptors	79
Waste Characteristics	40
Pathways	46
Total 167 divided by 3 =	56
Gross Total Score	

B. Apply factor for waste containment from waste management practices

Gross Total Score x Waste Management Practices Factor = Final Score

56 x 1.0 = 56